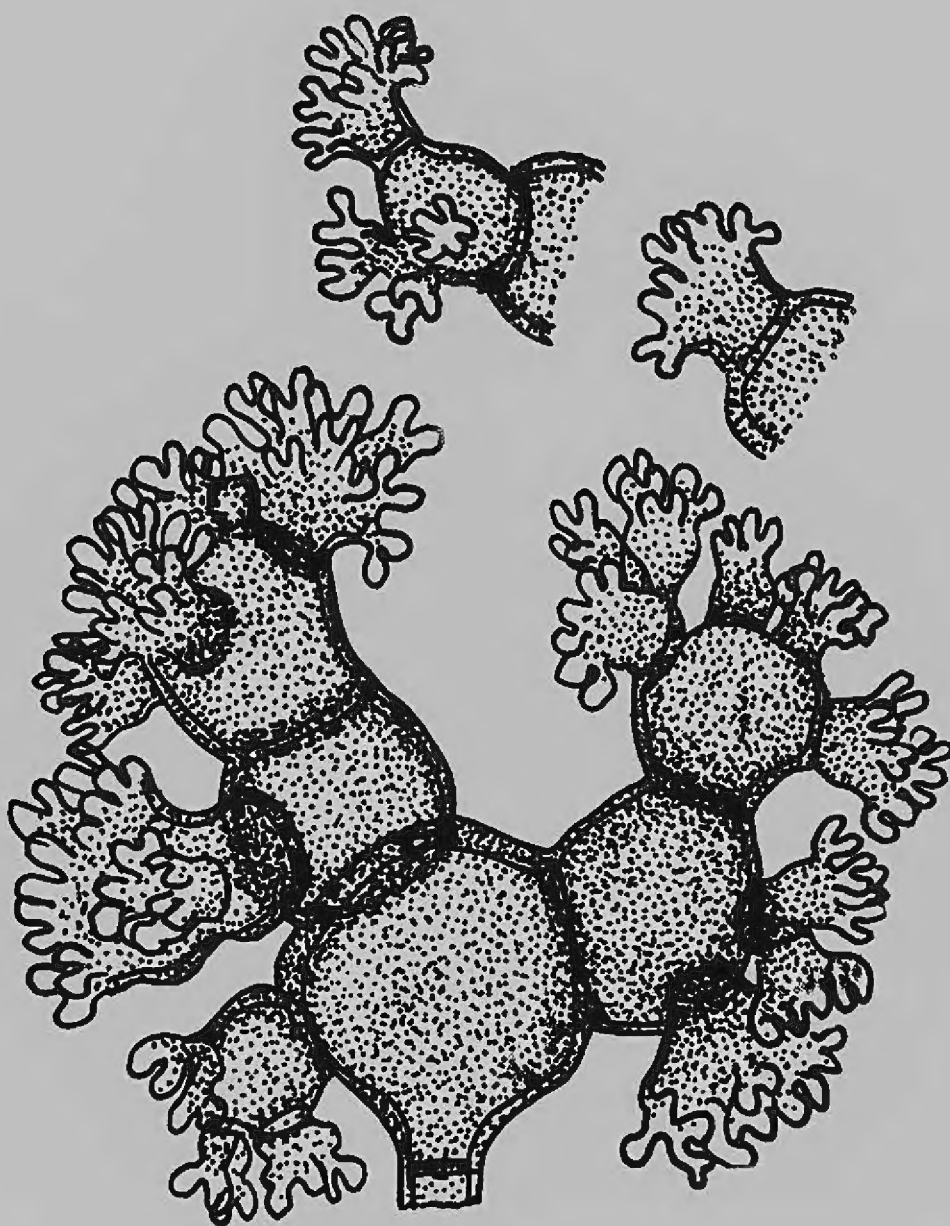


MYCOTAXON

THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

VOLUME 109

JULY–SEPTEMBER 2009



Castañeda & al.

FIG 33. *Phaeocandelabrum joseiturriagae* sp. nov.
(p. 231)

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Additions to the rust fungi of Fairy Meadows, the Northern Areas of Pakistan

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Abstract — *Puccinia silenigena* on *Silene* sp. is described as a new rust fungus from Fairy Meadows in the Pakistan Northern areas while *Leucotelium pruni-persicae* is a new record for Pakistan.

Key words — *Aquilegia pubiflora*, *Crossopsora*, Hunza, *Puccinia silenicola*

Introduction

The Northern Areas of Pakistan are very rich floristically. About 3000 species of plants exist in these areas, out of which approximately 124 species have medicinal properties (Sultan et al. 2006).

Until 2005, only 63 species of rust fungi had been described or reported from this 72,971 km² area (Ahmad 1956a,b; Gjaerum & Iqbal 1969; Kaneko 1993; Kakishima et al. 1993a,b; Khalid et al. 1995; Khalid & Iqbal 1996a,b, 1997; Ahmad et al. 1997; Sultan 2005; Sultan et al. 2008). This paper is a continuation of the enumeration of rust fungi of this area.

In this present work, *Puccinia silenigena* is described as a new rust fungus on *Silene* sp. from Fairy Meadows in the Northern Areas of Pakistan. *Leucotelium pruni-persicae* is a new record for Pakistan. *Puccinia brachypodii* var. *poae-nemoralis* is an addition to the rust flora of Northern Areas of Pakistan with *Anthoxanthum odoratum* as a new host for rust fungi of Pakistan.

Materials and methods

Specimens were collected from the Northern Areas of Pakistan. Freehand sections of infected tissues and spores were mounted in lactophenol and gently heated to boiling. The preparations were observed under a NIKON YS 100 microscope and photographed with a digipro-Labomed and Scanning Electron Microscope. Drawings of spores and paraphyses were made using a Camera

* Corresponding author

Lucida (Ernst Leitz Wetzlar, Germany). Spore dimensions were taken with an ocular micrometer. At least 25 spores were measured for each spore state. The rusted specimens have been deposited in the Herbarium of Botany department, University of the Punjab, Lahore (LAH).

Enumeration of taxa

Puccinia silenigena S.H. Iqbal, Afshan & Khalid, sp. nov.

FIGS. A–C

MYCOBANK MB 514034

Spermogonia et aecia ignota. Uredinia amphigena, brunnea. Urediniosporae ovoideae vel ellipsoideae, 19–26 × 23–32 μm (mean 22.64 × 27.29 μm); membrana 1.5–2 μm crassa, pallidae-brunneae, echinulatae; poris germinationis 3–4, obscurae. Telia amphigena, atra. Teliosporae ellipsoideae vel obovoideae, medio leviter constrictae, raro diorchidioideae, (16–)19–24 × (29–)31–42(–46) μm (mean 21.42 × 36.67 μm); membrana 1.5–2 μm crassa, castaneo-brunneae; apice 2–5 μm crassa; poro germinationis 1 per cellulam, subapicaliter vel aequatorialis; pedicello hyalinae, oblique.

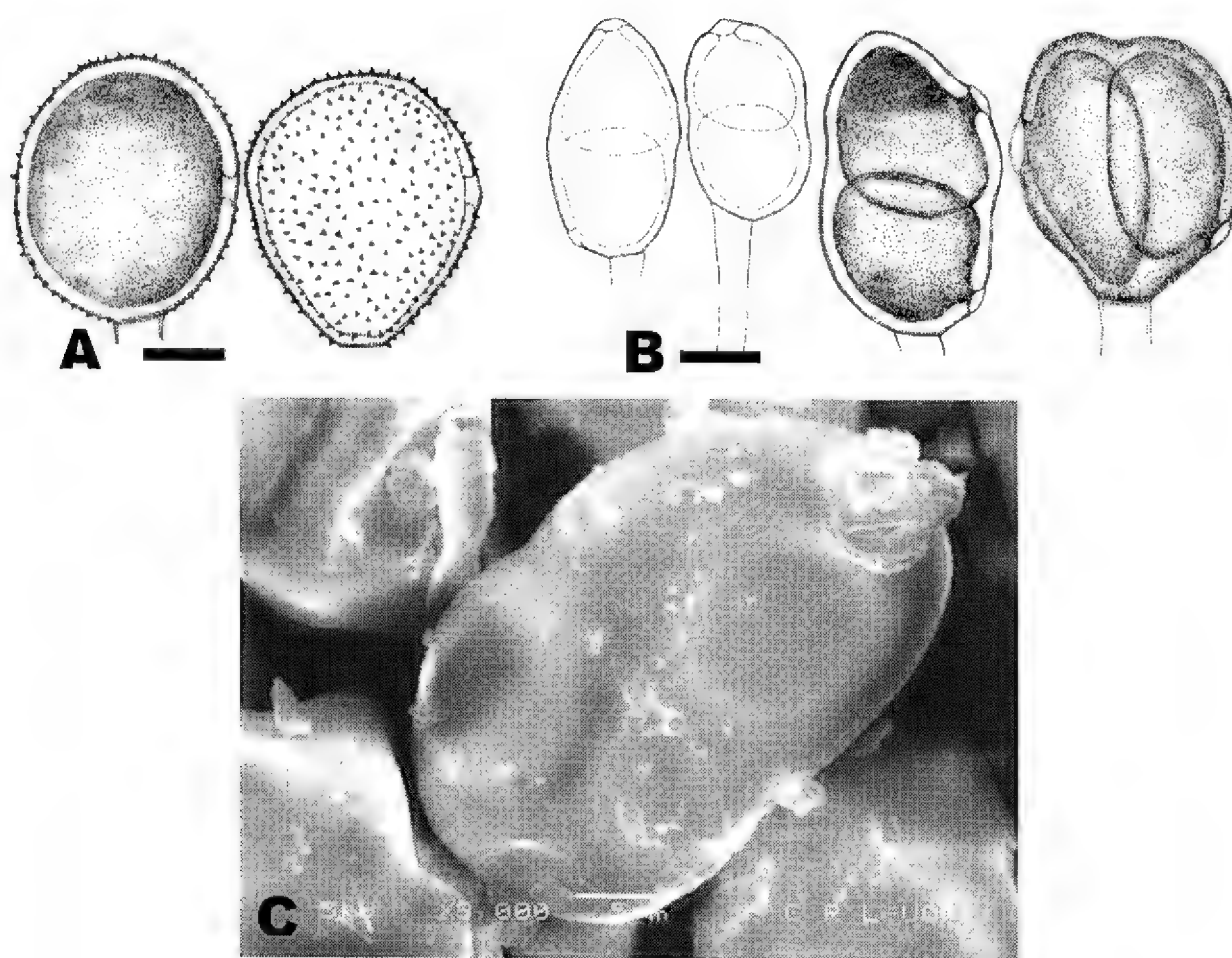
HOLOTYPE: On *Silene* sp., with II & III stages, Pakistan, Northern Areas, Fairy Meadows, at 3,036 m a. s. l., 12th August, 2007. NSA # G 11. (LAH Herbarium No. NSA 1088).

ETYMOLOGY: Named after the host plant, *Silene* sp.

SPERMOGONIA and **AECIA** unknown. **UREDINIA** amphigenous, brown, 0.1–0.2 × 0.2–0.4 mm. **UREDINIOSPORES** ovoid to ellipsoid, 19–26 × 23–32 μm (mean 22.64 × 27.29 μm); wall 1.5–2 μm thick, pale brown, echinulate; germ pores 3–4, obscure; pedicel hyaline, short, 6–8 × 15–20 μm. **TELIA** mostly amphigenous, 0.2–0.4 × 0.2–0.6 mm, black. **TELIOSPORES** ellipsoid to obovoid, rounded at both ends, sometimes diorchidioid, not or slightly constricted at the septum, (16–)19–24 × (29–)31–42(–46) μm (mean 21.42 × 36.67 μm); wall 1.5–2 μm thick, smooth, chestnut brown; apex 2–5 μm thick; germ pore 1 per cell, upper sub-apical, lower at the equator or near the septum; pedicel short, hyaline, obliquely attached, 5–6 × 24–30 μm.

COMMENTS: Previous reports from Pakistan of rust fungi on *Silene* spp. are *Uromyces behenis* (DC.) Unger on *Silene vulgaris* (Moench) Garcke from Swat (Ono & Kakishima 1992) and *S. aucheriana* Boiss. from Quetta (Khalid et al. 1995); and *Puccinia behenis* G.H. Otth on *S. aucheriana* from Naltar valley, Gilgit (Ahmad 1969: 110). Other rust fungi reported elsewhere on *Silene* spp. include *P. arenariae* (Schumach.) J. Schröt., *P. silenicola* Sousa da Câmara et al., and *U. inaequaltus* Lasch (Wilson & Henderson 1966: 62–64).

P. silenigena resembles *P. behenis* in uredinio–teliospore size and wall ornamentation. The major difference between the two *Puccinia* species is that *P. silenigena* has ellipsoid to diorchidioid teliospores with an obliquely attached pedicel while *P. behenis* has oblong to ellipsoid teliospores. In *P. silenigena*, the germ pore of upper cell is apical or sub-apical while *P. behenis* has an apical germ pore in the upper cell.

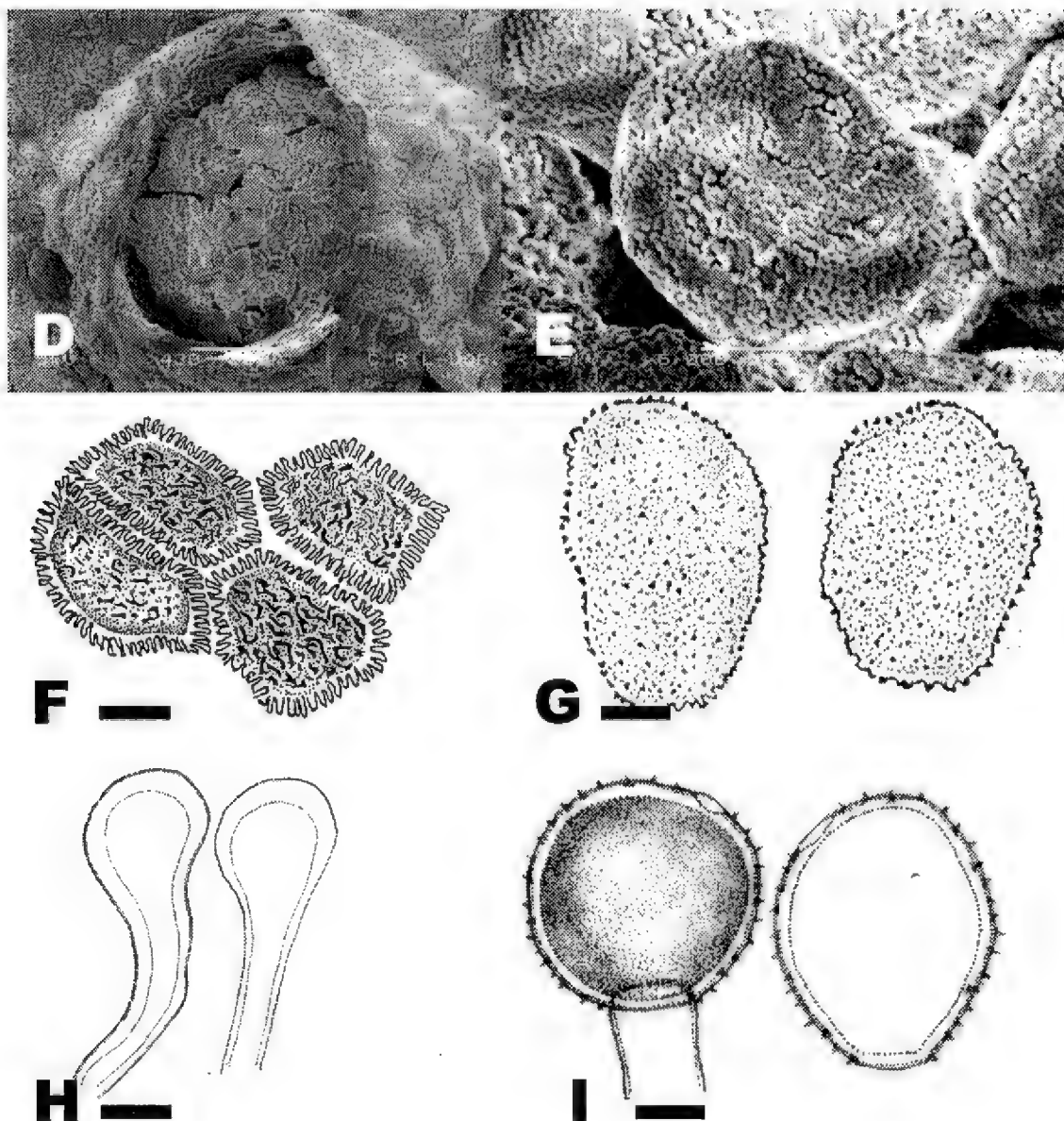


FIGS. A–C: *Puccinia silenigena* (type)
 (A). Lucida drawings of urediniospores and (B). Teliospores
 (C). SEM photograph of a smooth walled teliospore.
 Scale bar for A = 9 μm , B = 8 μm , C = 5 μm .

P. silenigena somewhat resembles *P. silenicola* in spore shape and wall ornamentation. However, *P. silenigena* differs in spore size with larger (19–26 \times 23–32 μm vs. 18–22 \times 17–26.5 μm) urediniospores and wider ((16–)19–24 μm vs. 15–19 μm) teliospores compared to *P. silenicola*. Another characteristic difference is the presence of thinner (2–5 μm vs. 6–8.5 μm) teliospore apices with shorter (24–30 μm vs. 120 μm) pedicels in *P. silenigena*.

Leucotelium pruni-persicae (Hori) Tranzschel, Sovetska Bot. 4: 83 (1935) FIGS. D–I
 = *Puccinia pruni-persicae* Hori, Phytopathology 2: 144 (1912)
 = *Sorataea pruni-persicae* (Hori) Cummins & Y. Hirats., Illustr. Gen. Rust Fungi, rev. edit. (St. Paul): 147 (1983).

TELIA not found. SPERMOGONIA hypophyllous, inconspicuous, 0.1–0.25 mm wide and 0.2–0.3 mm high, honey colored to reddish brown, surrounded by aecia. AECIA hypophyllous, scattered, on leaves, petioles and branches, yellow to yellowish orange, 0.2–0.3 \times 0.3–0.4 mm, cup shaped, clustered together in the form of a circle. AECIOSPORES subglobose or ovoid–obovoid, hyaline to light



FIGS. D–I: *Leucotelium pruni-persicae* (D). SEM photograph of an aecium (E). SEM photograph of aeciospores showing verrucose wall ornamentation (F). Lucida drawing of peridial cells (G). Aeciospores (H). Capitulate paraphyses (I). Urediniospores. Scale Bar for F = 9 μm , G = 6 μm , H & I = 10 μm

yellow, sometimes with yellowish orange granules, verrucose, $15\text{--}20 \times 19\text{--}24 \mu\text{m}$. PERIDIAL CELLS hyaline to light yellow, rhomboidal to irregular in shape, verrucose to striately verrucose, $16\text{--}24 \times 23\text{--}27 \mu\text{m}$. UREDINIA hypophyllous, scattered or sometimes in groups, minute, light yellow to yellowish orange, powdery. UREDINIOSPORES globose to subglobose or obovoid to ellipsoid, $16\text{--}20 \times 18\text{--}25 \mu\text{m}$ (mean $17.69 \times 20.12 \mu\text{m}$); wall $1\text{--}1.5 \mu\text{m}$ thick, hyaline to light yellow, echinulate; germ pores obscure; pedicel hyaline, fragile, $6\text{--}8 \times 15\text{--}20 \mu\text{m}$. PARAPHYSES clavate to capitulate, hyaline to light yellow, $18\text{--}21 \mu\text{m}$ wide at apex, $8\text{--}10 \mu\text{m}$ thick at lower portion, wall of apex $2\text{--}5 \mu\text{m}$ thick, up to $71 \mu\text{m}$ long.

MATERIAL EXAMINED: On *Aquilegia pubiflora* Royle, with 0 & I stages, Pakistan, North West Frontier Province (NWFP), Ayubia National Park, at 2,135 m a. s. l., 24th May, 2006. NSA # 05. (LAH Herbarium No. NSA 1016); on *Prunus amygdalus* Batsch, with II stage, Pakistan, Northern Areas, Hunza, at 2,440 m a. s. l., 13th August, 2007, NSA # G18. (LAH Herbarium No. NSA 1017).

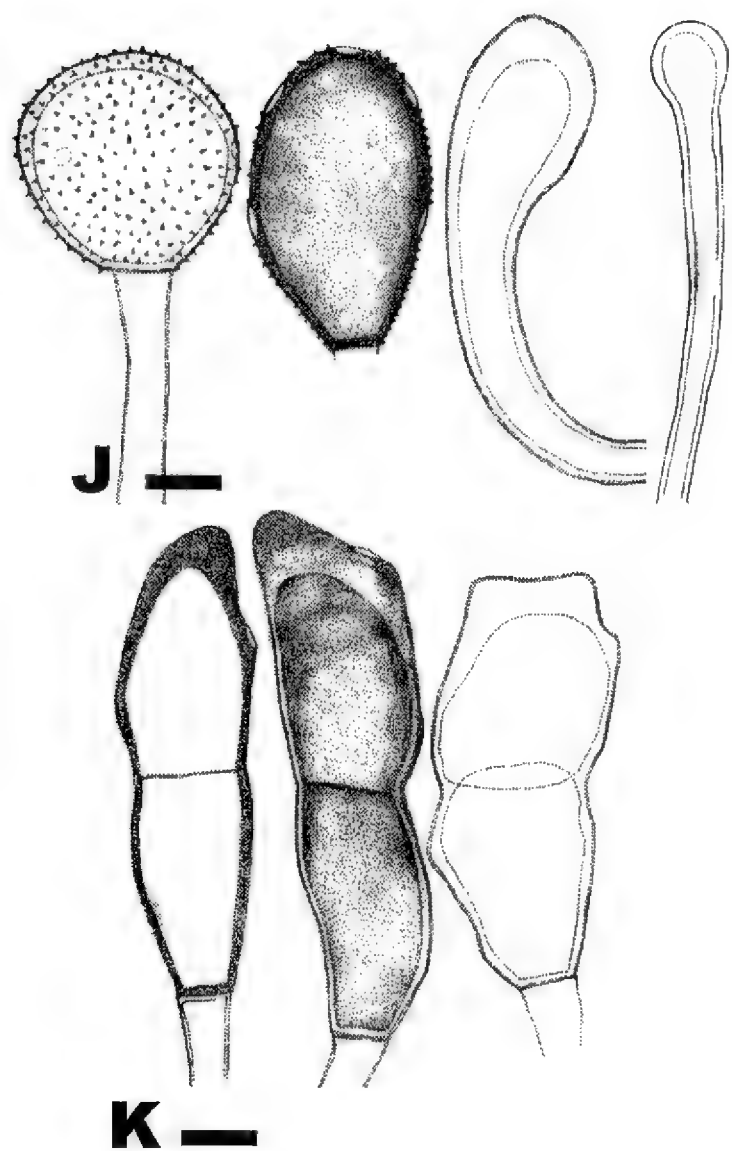
COMMENTS: *Leucotelium pruni-persicae* is a new record for Pakistan. *Tranzschelia pruni-spinosae* (Pers.) Dietel and *T. pruni-spinosae* var. *discolor* (Fuckel) Dunegan (\equiv *T. discolor* (Fuckel) Tranzschel & M.A. Litv.) were previously reported on *Prunus amygdalus* and *P. persica* (L.) Batsch from Tandojam and Choa Saiden Shah by Khan & Kamal (1968), Ahmad (1956a,b), Malik et al. (1968), Malik & Virk (1968), and Ahmad (1976). In China and Japan, *L. pruni-persicae* has been reported on *Aquilegia* species as the aecial hosts and *Prunus* species as the telial hosts (Farr et al. 2008).

Puccinia brachypodii var. *poae-nemoralis* (G.H. Otth) Cummins & H.C. Greene, Mycologia 58: 705 (1966) FIGS. J–K
 \equiv *Puccinia poae-nemoralis* G.H. Otth, Mitt. naturf. Ges. Bern: 113 (1871) [“1870”]
 $=$ *Puccinia anthoxanthina* Gäum., Ber. Schweiz. bot. Ges. 55: 74 (1945)

SPERMOGONIA and AECIA not seen. UREDINIA mostly on adaxial surface, yellowish or yellowish brown, 0.09–0.2 \times 0.2–0.4 mm. UREDINIOSPORES obovoid or ellipsoid to broadly ellipsoid, 19–26 \times 23–36 μ m (23.18 \times 28.63 μ m); wall 2–3 μ m thick, light brown to cinnamon brown, closely echinulate; germ pores 5–9, obscure; pedicel hyaline, short, 7–8 \times 38–45 μ m. PARAPHYSES cylindric to capitate, hyaline or yellowish, mostly 80–100 μ m long and 14–18 μ m wide, usually geniculata, wall 2–4 μ m thick throughout or to 6 μ m thick in the head. TELIA mostly on the abaxial surface, covered by the epidermis, 0.06–0.1 \times 0.1–0.2 mm, black, loculate with a few brown paraphyses surrounding the sori. TELIOSPORES oblong to clavate, 13–24 \times 40–59(–65) μ m (mean 17.72 \times 50.58 μ m), not or slightly constricted at the septa; wall 1–1.5 μ m thick, smooth, brown to chestnut brown or paler basally; apex 5–9 μ m thick, truncate or conical; germ pore 1 per cell, upper sub-apical, lower at the equator or near the septum; pedicel short, light brown, not collapsing, thick walled, 5–6 \times 9–15 μ m. Few one-celled spores also observed.

MATERIAL EXAMINED: On *Anthoxanthum odoratum* L., with II + III stages, Pakistan, Northern Areas, Karimabad, Hunza, at 2,438 m a. s. l., 13th August, 2007. NSA # Gr 58 (G06). (LAH Herbarium No. NSA 1035).

COMMENTS: *Puccinia brachypodii* var. *poae-nemoralis* has previously been reported on leaves of *Agrostis munroana* Aitch. & Hemsl., *Poa nemoralis* L., *P. pratensis* L., and *P. sterilis* M. Bieb. from Kaghan valley, Sharhan, Swat, and Azad Jammu & Kashmir (Ahmad et al. 1997). The aecial state is known to occur on *Berberis* species elsewhere in the western Himalayas (Joshi & Payak 1963).



FIGS. J–K: Lucida drawings of *Puccinia brachypodii* var. *poae-nemoralis* (J).
Urediniospores and paraphyses (K). Teliospores.
Scale bar = 10 μ m.

P. brachypodii var. *poae-nemoralis* is reported here for the first time from Hunza, Northern Areas of Pakistan, and *Anthoxanthum odoratum* is recorded for the first time as a host for rust fungi in Pakistan, although it is a host elsewhere in the world (Farr et al. 2008).

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We sincerely thank Dr. George Newcombe, University of Idaho, and Dr. William R. Bushnell, University of Minnesota, for their valuable suggestions to improve the manuscript and acting as presubmission reviewers. We are also highly obliged to Higher Education Commission (HEC) of Pakistan for providing financial support.

Literature cited

- Ahmad S. 1956a. *Uredinales* of West Pakistan. *Biologia* 2(1): 29–101.
- Ahmad S. 1956b. Fungi of Pakistan. Biological Society of Pakistan, Lahore Monograph 1: 1–126.
- Ahmad S. 1969. Fungi of Pakistan. Biological Society of Pakistan, Lahore Monograph 5, Suppl. 1: 110.
- Ahmad S. 1976. Contribution to the fungi of Pakistan. XVII. *Sultania* 2: 17–21.
- Ahmad S, Iqbal SH, Khalid AN. 1997. Fungi of Pakistan. Nabiza Printing Press, Karachi, Pakistan.
- Farr DE, Rossman AY, Palm ME, McCray EB. 2008. Fungal Databases. Online. Systematic Mycology and Microbiology Laboratory, USDA-ARS, Washington, DC.
- Gjaerum HB, Iqbal SH. 1969. Some rust fungi from West Pakistan. *Nytt. Mag. Bot.*, 16: 221–223.
- Joshi LM, Payak MM. 1963. A *Berberis Aecidium* in Lahaul Valley, western Himalayas. *Mycologia* 55(2): 247–250.
- Kakishima M, Izumi O, Ono Y. 1993a. Rust Fungi (*Uredinales*) of Pakistan collected in 1991. *Cryptogamic Flora of Pakistan* 2: 169–179.
- Kakishima M, Izumi O, Ono Y. 1993b. Graminicolous Rust Fungi (*Uredinales*) from Pakistan. *Cryptogamic Flora of Pakistan* 2: 181–186.
- Kaneko S. 1993. Parasitic fungi on woody plants from Pakistan. *Cryptogamic Flora of Pakistan*, Vol. 2 (Eds. T. Nakaike and S. Malik), Nat. Sci. Mus., Tokyo, Japan. pp. 149–168.
- Khalid AN, Iqbal SH. 1996a. Additions to the Rust Flora of Pakistan. *Pak. J. Bot.* 28(1): 114–117.
- Khalid AN, Iqbal SH. 1996b. New Rusts from Pakistan. *Can. J. Bot.* 74: 506–508.
- Khalid AN, Iqbal SH. 1997. *Puccinia deosaiensis* sp. nov. on *Epipactis helleborine* (L.) Crantz. *Can. J. Bot.* 75: 864–886.
- Khalid AN, Iqbal SH, Masood A. 1995. New records of *Uredinales* from Pakistan. *Science International* 7(4): 531–532.
- Khan SA, Kamal M. 1968. The fungi of South West Pakistan. Part 1. *Pak. J. Sci. & Ind. Res.* 11: 61–80.
- Malik SA, Virk. 1968. Contribution to the knowledge of parasitic fungi of Quetta-Kalat Region. *Biologia* 14: 27–35.
- Malik SA, Javaid MT, Ahmad M. 1968. *Uredinales* of Quetta-Kalat region of Pakistan. *Biologia* 14: 37–46.
- Ono Y, Kakishima M. 1992. *Uredinales* collected in the Swat Valley, Pakistan. *Cryptogamic flora of Pakistan* 1: 197–216.
- Sultan MA. 2005. Taxonomic study of rust flora of Northern Areas of Pakistan. Ph.D. Thesis, University of the Punjab. Lahore, Pakistan.
- Sultan MA, Haq I, Khalid AN, Bajwa R. 2006. Some *Uredinales* from northern areas of Pakistan. *Pak. J. Bot.* 38(3): 837–841.
- Sultan MA, Haq I, Khalid AN, Mukhtar H. 2008. Two new anamorphic rust fungi from northern areas of Pakistan. *Mycotaxon* 105: 23–27.
- Wilson M, Henderson DM. 1966. British rust fungi, Cambridge University Press, Cambridge, pp. 62–64.

An anamorphic genus and species newly recorded from Turkey

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Abstract — *Diplosporonea delastrei* is reported for the first time from Turkey on *Silene latifolia* subsp. *alba*. Description and illustrations are presented, all based on Turkish material.

Key words — microfungi, coelomycetes, new record

Introduction

Turkey is one of the richest areas in the middle latitudes in terms of plant diversity. Turkish flora includes 12,000 species and still a great number of new species are being described (Avcı 2005). This diversity of the host species is an important factor for the diversity of microfungi as well, making microfungi biota in Turkey very rich. The first data on micromycetes, including coelomycetes, were recorded by Bremer et al. (1947, 1952) and Petrak (1953). The subsequent data on coelomycetes were published in the paper devoted to diseases of cultivated plants (Karel 1958) and as results of the research by Göbelez (1967). Observations on coelomycetes in Turkey have increased during last decade (Altan & Tamer 1996, Hüseyinov & Selçuk 1999, Braun et al. 2000, Hüseyinov 2000, Hüseyin & Selçuk 2001, Hüseyinov et al. 2002, Selçuk et al. 2003, Kırbağ 2004, Mel'nik et al. 2004, Hüseyin et al. 2005, 2007, Erdoğan & Hüseyin 2007).

Material and methods

Microscopic examination and microphotographs were done by means of Leica DM E light microscope. Novex P-20 stereo microscope was used for close-up photo of the acervuli on leaf surface. Conidiomata sections were prepared by razor blade. The fungus was identified using the relevant literature (Ellis & Ellis 1985, Ignatavičiūtė & Treigienė 1998, Sutton 1980). The host plant was identified using the “Flora of Turkey and East Aegean Islands” (Davis 1967). The examined specimen is deposited in the mycological collection of Ahi

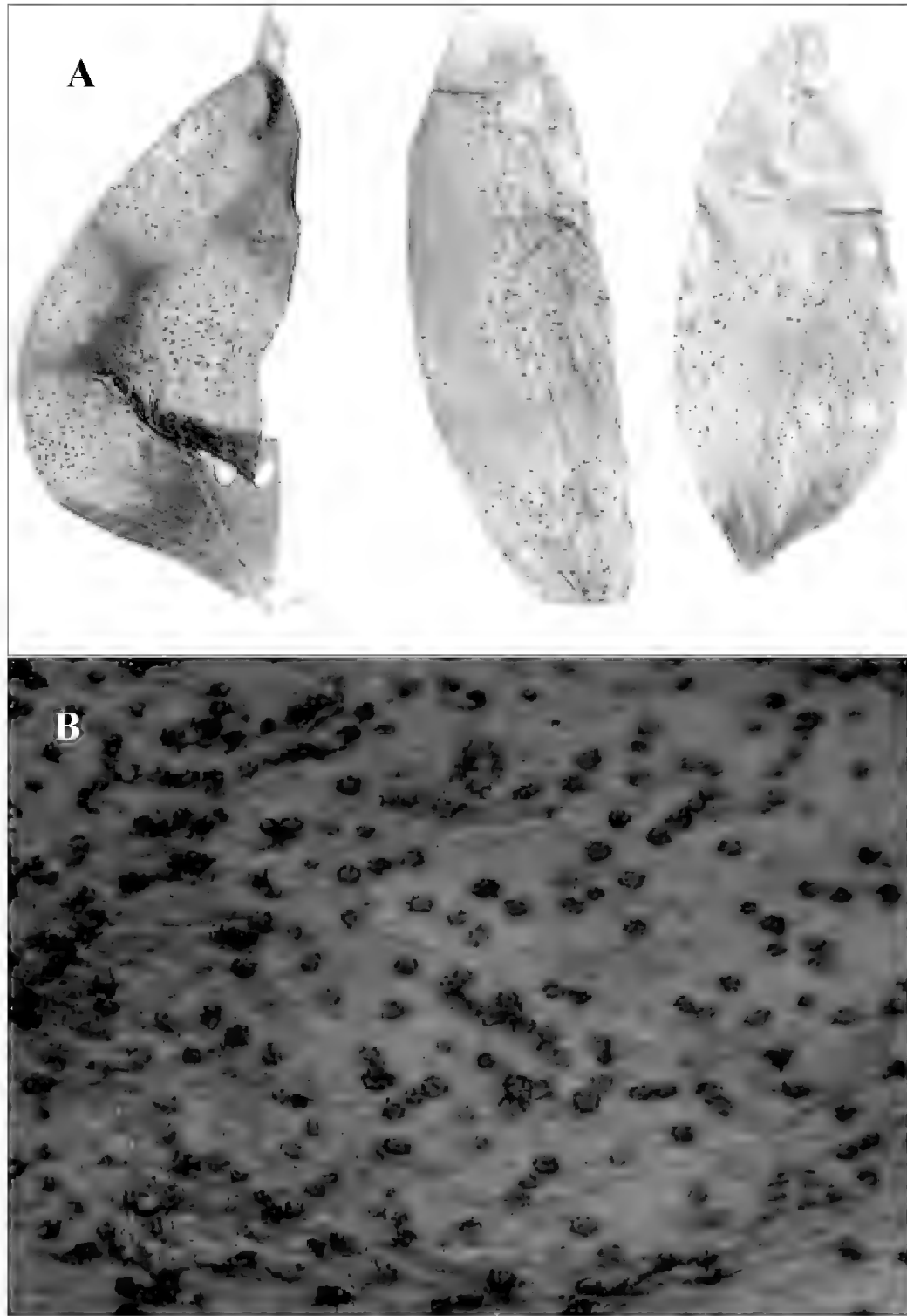


FIG. 1. *Diplosporonema delastrei*.
A. Leaf spots. $\times 2$; B. Acervuli on leaf. $\times 40$.

Evran University, Arts and Sciences Faculty, Department of Biology, in Kırşehir province of Turkey.

Results

The genus *Diplosporonema* and its species *D. delastrei* have not been reported for Turkey in the literature. Description and illustrations of this species based on a Turkish collection are given on the next page.



FIG. 2. *Diplosporonema delastrei*.

A. Vertical section of a conidioma. Scale bar = 18 µm.

B. Conidia. Scale bar = 10 µm.

Diplosporonema delastrei (Lacroix) Petr., Sydowia 1: 74, 1947.

Gloeosporium delastrei Lacroix, in Montagne, Annales des
Sciences Naturelles, Botanique, Série 4, 5: 345, 1856.

Marssonina delastrei (Lacroix) Sacc., Michelia 2(6): 119, 1880.

Marssonina delastrei (Lacroix) Magnus, Hedwigia 45: 89, 1906.

Phragmosporonema delastrei (Lacroix) Moesz & Smarods,
in Moesz, Magyar Bot. Lapok 33: 52, 1934.

FIGS. 1–2

Foliicolous. Spots on both sides of leaves, pale yellow to pale brown on the upper surface, pale brown on the lower, sometimes purple-bordered, regular or irregularly rounded, 0.3–1.5 cm diam, sometimes elongated, 1.5–2.5 × 0.4–1 cm (FIG. 1A). CONIDIOMATA acervular, amphigenous, epidermal to subepidermal, scattered, yellowish, circular, 100–165 µm diam, thin-walled, *textura angularis* (FIG. 1B, 2A). CONIDIOPHORES hyaline, smooth, septate, branched penicillately or irregularly at the apex, 20–30 × 2–4 µm, developing from the upper pseudoparenchyma. CONIDIOGENOUS CELLS hyaline, cylindrical to subcylindrical, 6–12 × 4.5–5.5 µm, holoblastic, sympodial, indeterminate, integrated or discrete, smooth, with 1–2 conidia formed sympodially from broad, flat, unthickened scarcely protuberant scars. CONIDIA hyaline, straight or curved, subcylindrical to clavate, 17.5–25 × 5–6.5 µm, smooth, thin walled, eguttulate, 1–2-euseptate, not constricted, base truncate, apex obtuse (FIG. 2B).

SPECIMEN EXAMINED — TURKEY, Erzincan Prov., Kemaliye, Ipek road, on living leaves of *Silene latifolia* subsp. *alba* (Mill.) Greuter & Burdet (= *Silene alba* (Mill.) E.H.L. Krause) (*Caryophyllaceae*), alt. 1311 m, 04-VII-2007, coll. M. Erdoğan (ME 2012).

Discussion

Höhnelt (1917) introduced the generic name *Diplosporonema* for *Gloeosporium delastrei*, the conidial state of the teleomorphic species *Pyrenopeziza agrostemmatidis* Fuckel [= *Diplocarpon saponariae* (Ces.) Nannf.]. However, he did not recombine *G. delastrei* in the new genus. The binominal *Diplosporonema delastrei* was not validly published until Petrak (1947) presented it as the correct name for *Phragmosporonema delastrei* (pointing out that *Phragmosporonema* Moesz is a superfluous name based on the same type as *Diplosporonema* Höhn.).

Diplosporonema delastrei (the only species in the genus) develops on leaves, rarely stems, of numerous genera of the *Caryophyllaceae*. It is known from Africa, Asia, Europe and North America (Grove 1937, Švarzman et al. 1971, Ignatavičiūtė & Treigienė 1998, Sutton 1980, Andrianova & Golubtsova 2006, and others).

Acknowledgments

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Literature cited

- Andrianova TV, Golubtsova JI. 2006. Anamorphic fungi of plant communities of Novgorod-Siversk Polissya. Ukr. Botan. Journ. 63(6): 765–776.
- Altan Y, Tamer AÜ. 1996. The parasitic fungi occurring on some endemic plants in Turkey and their damaging effects. In: MA Öztürk et al. (eds), Plant life in South-West and Central Asia. Ege University Press: İzmir (Turkey), pp. 398–401.
- Avcı M. 2005. Diversity and endemism in Turkey's vegetation. Coğrafya Dergisi 13: 27–55.
- Braun U, Mel'nik V, Hüseyinov E, Selçuk F. 2000. *Mycopappus alni* on species *Betula* and *Pyrus* from Turkey. Mikologia i Fitopatologia 34(6): 1–2.
- Bremer H, Ismen H, Karel G, Özkan M. 1947. Beiträge zur Kenntnis der parasitischen Pilze der Türkei. I. Revue de la Faculté des Sciences de l'Université d'Istanbul. Ser. B 12(2): 307–334.
- Bremer H, Karel G, Bıyıkoglu K, Göksel N, Petrak F. 1952. Beiträge zur Kenntnis der parasitischen Pilze der Türkei. VI. Revue de la Faculté des Sciences de l'Université d' Istanbul. Ser. B 17(3): 259–275.
- Davis PH (ed.). 1967. Flora of Turkey and East Aegean Islands. Vol. 2. Edinburgh University Press: Edinburgh. 581 pp.
- Ellis BM, Ellis JP. 1985. Microfungi on land plants. Croom Helm: London, Sydney. 818 pp.
- Erdoğan M, Hüseyin E. 2007. The world's second record of *Hyalodictyum colchicum* reported from Turkey. Mycotaxon 99: 245–250.
- Göbelez M. 1967. La mycoflore de Turguie. II. Mycopathologia et Mycologia Applicata 23(1): 47–67.
- Grove WB. 1937. British stem- and leaf-fungi (*Coelomycetes*). Vol. 2. Cambridge University Press: London. 407 pp.
- Höhnelt F von. 1917. Fragmente zur Mycologie no. 1017. Über *Pyrenopeziza agrostemmatidis* Fuckel. Sber. Akad. Wiss. Wien 126: 333–335.
- Hüseyin E, Selçuk F. 2001. New and poorly known genera of microfungi for Turkey. Turk. J. Bot. 25(6): 437–438.
- Hüseyin E, Selçuk F, Sahin A. 2005. The world's second record of *Neoheteroceras flageoletii* reported from Turkey. Mycotaxon 94: 241–244.
- Hüseyin E, Erdoğan M, Bülbül AS. 2007. A new species of *Cylindrosporium*. Mycotaxon 101: 325–330.
- Hüseyinov E. 2000. New records of microfungi for Turkey. Israel Journal of Plant Sciences 48(1): 75–78.
- Hüseyinov E, Selçuk F. 1999. New records of phytopathogenic microfungi for Turkey. Plant Disease Research 14(2): 175–176.
- Hüseyinov E, Mel'nik V, Selçuk F. 2002. *Ceratophorum helicosporum* – a new for mycoflora of Turkey genus and species of *Hyphomycetes* (*Dematiaceae*). Mikologia i Fitopatologia 36(3): 11–13.
- Ignatavičiūtė M, Treigienė A. 1998. Mycota Lithuaniae. Vol: 9, *Melanconiales*. UAB 'Valstiečių laikraštis': Vilnius. 246 pp.
- Karel GA. 1958. A preliminary list of plant disease in Turkey. Ayyıldız Matb: Ankara. 44 pp.
- Kırbağ S. 2004. New records of microfungi from Turkey. Pak. J. Bot. 36(2): 445–448.
- Mel'nik V, Hüseyin E, Selçuk F. 2004. Contribution to the studying of micromycetes in several Black Sea provinces of Turkey. Novosti Sistematiki Nizshikh Rasteniy. Nauka: Sankt-Petersburg. 37: 133–148.
- Petrak F. 1947. Kritische Bemerkungen über einige, in letzter Zeit als neu beschriebene Ascomyzeten und Fungi imperfecti. Sydowia 1(1–3): 61–79.

- Petrak F. 1953. Neue Beiträge zur Pilzflora der Türkei. Sydowia 7(1–4): 14–44.
- Selçuk F, Hüseyin E, Bitmiş K. 2003. Some materials on mitosporic fungi from Turkey. II. *Coelomycetes*. Botanica Lithuanica 9(2): 161–170.
- Švarcman SR, Vasjagina MP, Pisareva NE, Byzova ZM. 1971. Flora sporavikh rasteniy Kazakistana. Vol. 7. Nesovershennye griby Fungi Imperfecti (*Deuteromycetes*) *Melanconiales*, Alma-Ata. 263 pp.
- Sutton BC. 1980. The *Coelomycetes*. Fungi imperfecti with pycnidia, acervuli and stromata. Commonwealth Mycological Institute: Kew. 696 pp.

***Asterostroma indicum* sp. nov.**

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Abstract — A new species of *Asterostroma*, *Asterostroma indicum*, is described and illustrated. The new species was found growing on the bark of a dead angiospermic log at Burdwan, West Bengal, India (altitude 30 m a.s.l.).

Key words — *Mangifera indica*, asterosetae, gloeocystidia

Introduction

During a mycological excursion at Burdwan, West Bengal, India (altitude 30 m a.s.l) the author collected a portion of a fresh resupinate basidiocarp growing on the bark of a dead log of *Mangifera indica* L. A microscopical examination showed it to be a species of *Asterostroma* Masee. A search of the available literature (Boidin et al. 1977, Parmasto 1970, Rattan 1977, Welden 1966) gave no clue to its identity, and it was concluded that it represented an undescribed species.

Materials and methods

This paper is based on a specimen collected from Burdwan, West Bengal, India. Colour notations are given using the Munsell Soil Colour Charts (1975). Microscopic study was carried on making free-hand sections of basidiocarp or as squash mounts in 2% aqueous solution of KOH and stained in 2% aqueous phloxine. Sections were also mounted in 10% KOH solution and Melzer's reagent. For studying microscopic characters of basidiocarp observations were also made on vertical sections and their teased portions mounted in distilled water and cotton blue in lactic acid (Kirk et al. 2001). Basidiospores were measured including the length of the tubercles.

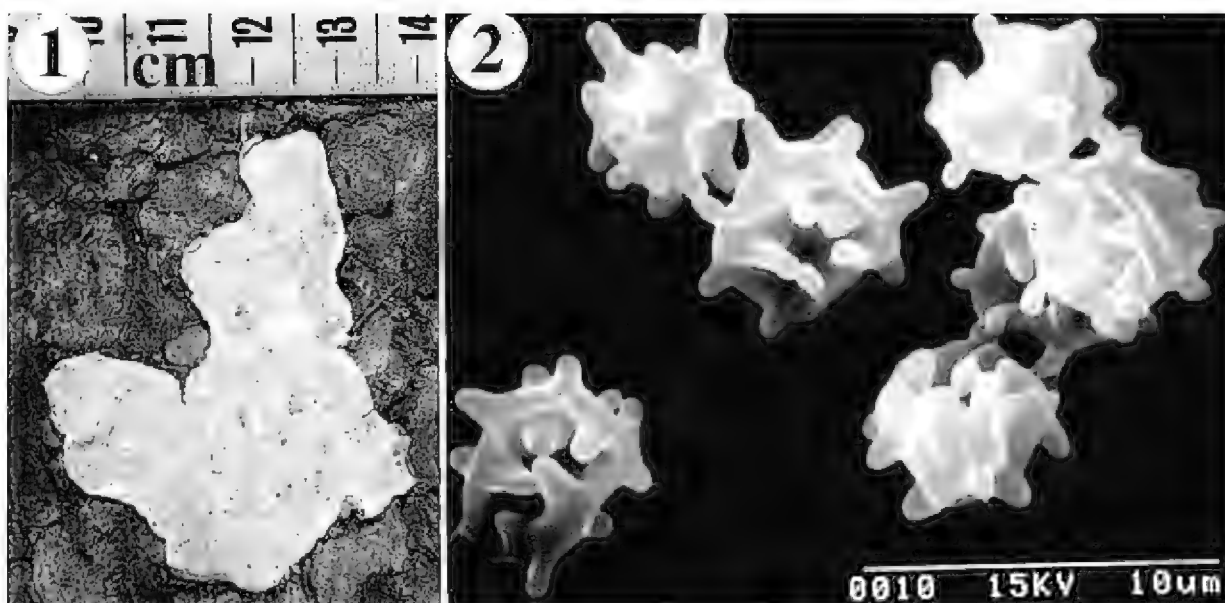
Taxonomy

***Asterostroma indicum* A.B.De, sp. nov**

FIGURES 1–8

MYCOBANK MB509504

Carposoma resupinatum, membranaceum, spongiosum, ad 400 μ m crassum; hymenium laeve, non crevisum; systema hypharum monomiticum; hyphae generatoriae cum septis,



FIGS. 1–2. *Asterostroma indicum* (holotype): 1. basidiocarp; 2. basidiospores.

sinefibulis, hyalinae, diametro 2–4 µm; asteroetae numerosae, 3–5 radiatae; gloecystidia clavata, subcylindrica, cylindrica vel utriformia, tenuiter tunicata, apice obtuso, 40–44 × 6–8 µm; basidia hyalina, clavata, tetrasterigmatica, 20–24 × 5–6 µm; basidiosporae globosae, hyalinae, amyloideae, diametro (3.6–)4–4.8(–5.6) µm, incrassate tunicatae, tuberculatae, ad 1.5 µm, apice obtuso.

Typus: Lectus ad locum Burdwan, Bengalia occidentalis, India, die 14 octobri, 2004; **holotypus** positus in herb. BURD, herbario fungorum in sectio Botanicae, Burdwan Raj College, Burdwan, West Bengal, India (sub numero BRCMH AL 41); isotypus in herb. TAA (Estonia) conservatus (TAA).

ETYMOLOGY: *indicum*, growing in India

Basidiocarp (FIG. 1) resupinate, membranous, spongy, loosely adnate, up to 400 µm thick; hymenial surface light reddish brown (5YR 6/3), smooth, not creviced, dark brown in KOH; margin thinning, loosely adnate, concolourous with hymenial surface.

Hyphal system monomitic; generative hyphae (FIG. 4) simple septate, hyaline, thin- to very slightly thick-walled, branched, 2–4 µm wide; asteroetae (FIG. 5) abundant in context, mostly composed of 3–5 rays, rays up to 80 µm long and 8 µm broad, brown, subulate, unbranched or dichotomously branched, slightly darkening in KOH solution; gloecystidia (FIG. 6) numerous, thin-walled, hyaline, clavate to subcylindric, cylindric or utriform with obtuse apex, contents granular with numerous small and few large oil droplets, staining deeply with phloxine, immersed or projecting up to 25 µm out of the hymenium (FIG. 3), 40–44 × 6–8 µm; basidia (FIG. 7) hyaline, thin-walled, clavate, tetrasterigmatic, 20–24 × 5–6 µm, sterigmata up to 3 µm long; basidiospores (FIGS. 2 & 8) hyaline, slightly thick-walled, globose, amyloid, diameter (3.6–)4–4.8(–5.6) µm (mean diameter of 34 spores: 4.6 µm), tuberculate, tubercles cylindrical with obtuse apex, up to 1.5 µm long.

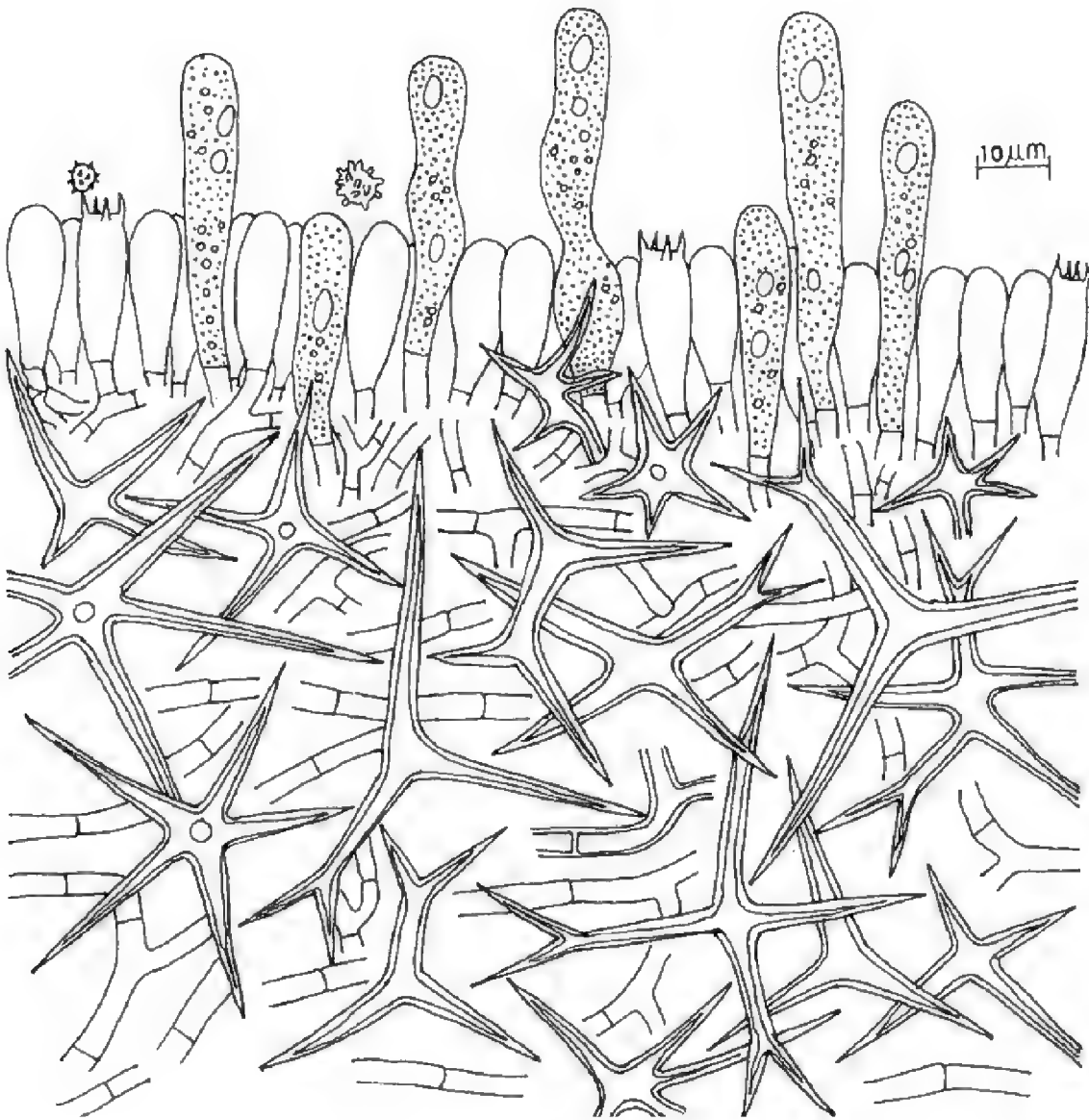


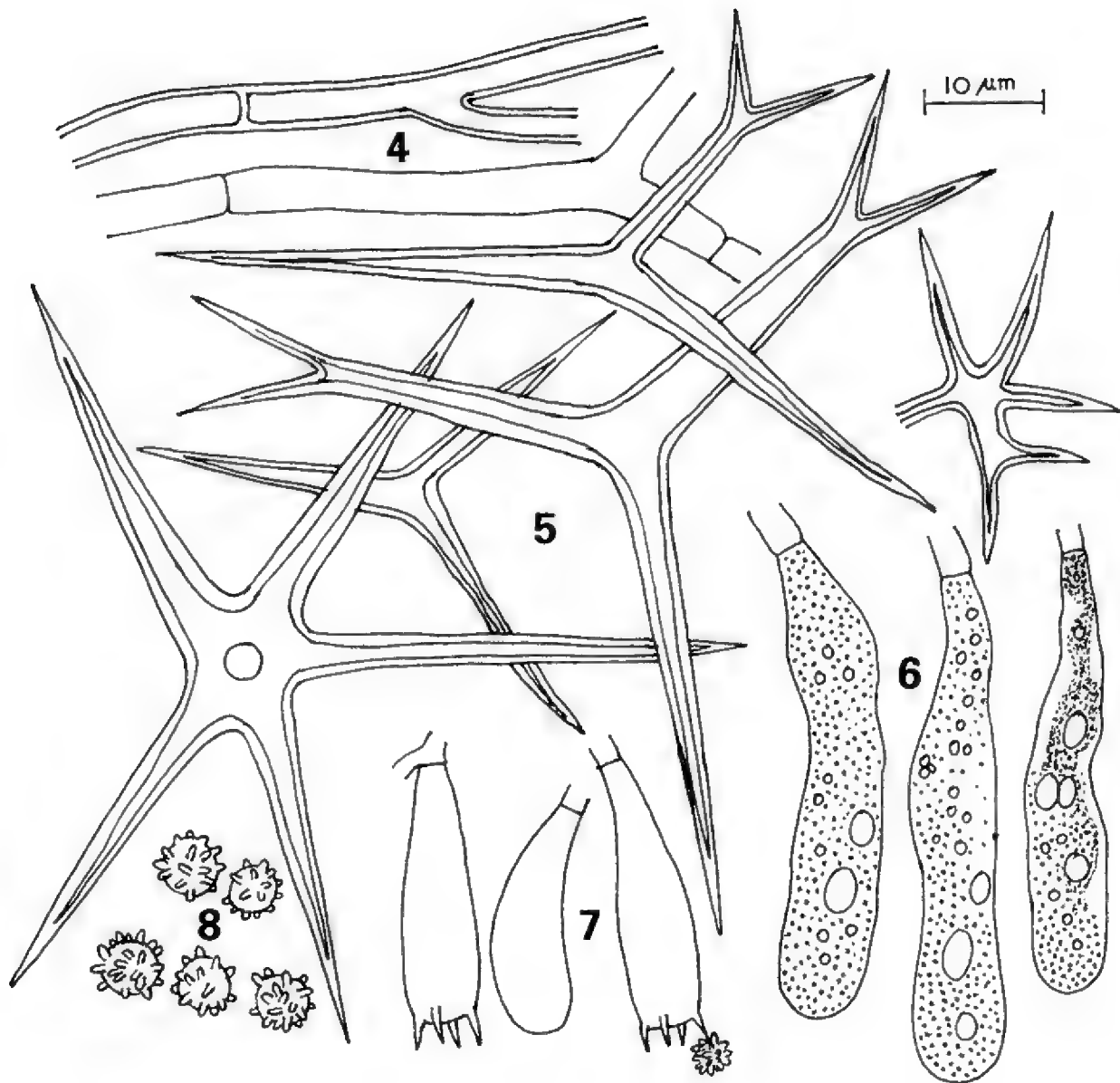
FIG. 3. Vertical section of basidiocarp of *Asterostroma indicum* showing asterosetae, simple-septate generative hyphae, gloeocystidia, basidia and basidiospores.

HABITAT: On bark of a log of *Mangifera indica* L.

DISTRIBUTION: Asia Tropical: India (found only in type locality near Burdwan, West Bengal).

Discussion

Asterostroma is a genus of the family *Lachnocladiaceae* that is characterized by resupinate basidiocarp with smooth hymenophore, monomitic hyphal system with simple septate generative hyphae, frequent gloeocystidia, and asterosetae (Parmasto 1970, Rattan 1977). As the fungus described above possesses almost all of these characters, it is described in the genus *Asterostroma*. *Asterostroma indicum* can be distinguished from all other *Asterostroma* species, however, by the following combination of features: (i) spongy, membranous, loosely

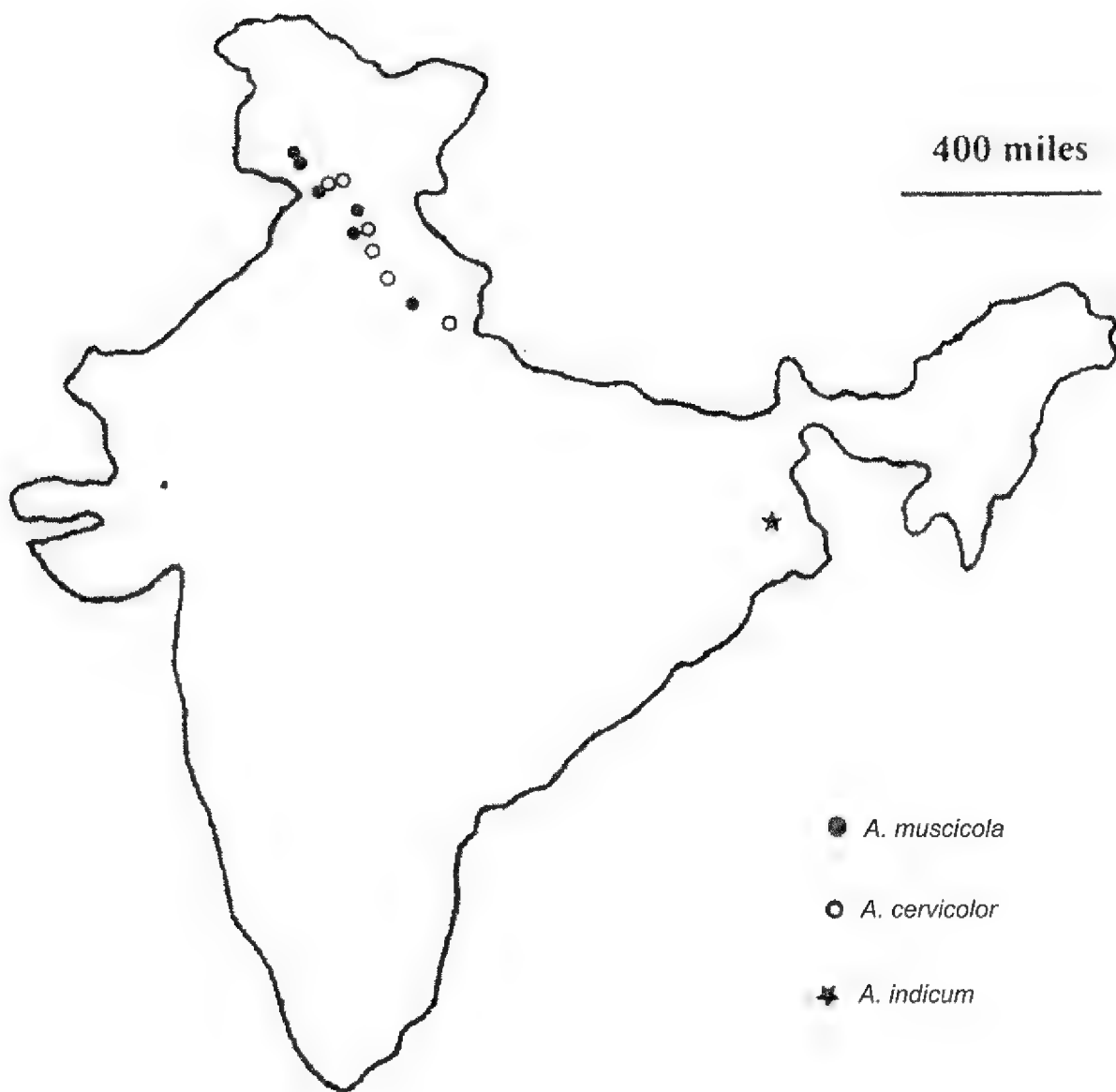


FIGS. 4–8. *Asterostroma indicum*: 4. generative hyphae; 5. asteroetae;
6. gloecystidia; 7. basidia; 8. basidiospores.

adnate basidiocarp up to 400 μm thick and with light reddish brown hymenial surface; (ii) occurrence on dead angiospermic wood; (iii) distribution in the plains of tropical India (altitude 30 m a.s.l); (iv) asteroetae comprising mostly 3–5 unbranched or dichotomously branched rays; (v) gloecystidia clavate to subcylindric, cylindric or utriform with granular contents and numerous oil droplets; (vi) basidia hyaline, thin-walled, clavate, tetrasterigmatic, 20–24 \times 5–6 μm ; (vii) basidiospores hyaline, slightly thick-walled, globose, amyloid, small (\sim 4–4.8 μm), and with cylindrical tubercles up to 1.5 μm long with obtuse ends.

Distribution of *Asterostroma* species in India

Previously in India only two species of *Asterostroma* were known, namely *A. cervicolor* (Berk. & M.A Curtis) Massee and *A. muscicola* (Berk. & M.A.



MAP 1. Distribution of the species of *Asterostroma* reported from India.

Curtis) Masseur growing on stump and log of *Abies pindrow* (Royle) Royle and *Cedrus deodara* (Roxb.) G. Don (Bilgrami et al. 1991, Rattan 1977, Sharma 1995) until I collected the species described here. *Asterostroma indicum*, therefore, represents the third species of *Asterostroma* in India. Among these three species, only *Asterostroma indicum* has been collected from the tropical plains of India; the other two species were collected from the coniferous forests of the temperate northwestern Himalayas. Locations of collections are given below [and distributions are shown on MAP 1.]

Asterostroma cervicolor: Chamba, Dalhousie, Mahasu and Simla (H.P.); Musoorie, Ranikhet (U.P.).

Asterostroma muscicola : Dalhousie, Mahasu and Kulu (H.P.); Hemkund (U.P.); Bhadarwah and Batot (J.K.).

Asterostroma indicum : Burdwan (W.B.).

Key to *Asterostroma* species in India

- 1. Tubercles of basidiospores almost hemispherical, very few of the asteroetae with dichotomously branched ray *A. cervicolor*
- 1. Tubercles of basidiospores conical or cylindrical with obtuse apex, many of the asteroetae with dichotomously branched rays 2
- 2. Basidiospores 6–8 µm in diameter with conical tubercles *A. muscicola*
- 2. Basidiospores 3.6–5.6 µm in diameter with cylindrical tubercles *A. indicum*

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References

Bilgrami KS, Jamaluddin S, Rizwi MA. 1991. Fungi of India (List and References). Today and Tomorrow's Printers and Publishers, New Delhi, India.

Boidin J, Lanquetin P, Gilles G. 1997. Contribution a la connaissance du genre *Asterostroma* Masee 1889 (*Basidiomycota*). Bull. Soc. Mycol. France 113: 269–301.

Kirk PM, Cannon PF, David JC, Stalpers JA, eds. 2001. Dictionary of the Fungi, 9th edn., Wallingford, UK: CABI Publishing.

Munsell soil colour charts. 1975. Macbeth Division of Kollmorgen Corporation, Baltimore.

Parmasto E. 1970. The *Lachnocladiaceae* of the Soviet Union with a key to boreal species. Scr. Mycol. 2. Inst. Zoology and Botany, Tartu, Estonia.

Rattan SS. 1977. The Resupinate *Aphylllophorales* of the North Western Himalayas. J. Cramer.

Sharma JR. 1995. *Hymenochaetaceae* of India. BSI, Calcutta, India.

Welden AL. 1966. West Indian species of *Asterostroma*, with notes on extralimital species. Amer. Midl. Naturalist 76 (1): 222–229.

Taxonomic notes on some powdery mildews from Inner Mongolia

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Abstract—The new combination *Erysiphe atraphaxis* var. *pluriappendicis* is introduced; and the taxonomy of four powdery mildew species is reassessed. *Erysiphe rabdosiae* is reduced to synonym with *E. bunkiniana*, and *E. shinii* is considered to be identical with *E. thermopsidis*.

Key words—*Erysiphaceae*, China

Introduction

Based on results of rDNA sequence analyses, scanning electron microscopic examinations of conidia and a reassessment of anamorphs and teleomorphs, Braun (1999) and Braun & Takamatsu (2000) proposed a fundamental phylogenetic revision of generic circumscription within the *Erysiphaceae*. The new classification of the powdery mildew fungi, discussed and outlined in detail by Braun et al. (2002), has recently been recognized and applied in connection with a comprehensive taxonomic exploration of the powdery mildew fungi of Inner Mongolia in China (Liu & Braun 2006, Liu et al. 2006, 2007; Liu 2007, Liu & Shang 2008). Results of these studies have been summarized by Liu (2007). Taxonomic novelties in the latter unpublished thesis are, however, not effectively published. Therefore, the new combination *Erysiphe atraphaxis* var. *pluriappendicis* is here validated. Furthermore, rich, new collections of powdery mildew on *Rabdosia japonica* var. *glaucocalyx* and *Thermopsis lanceolata* from Inner Mongolia allowed taxonomic reassessments of *Erysiphe bunkiniana*/*E. rabdosiae* and *E. shinii* (= *Microsphaera thermopsidis*)/*E. thermopsidis*, respectively.

Materials and methods

Material was mounted in distilled water and examined using 100× oil immersion objectives (bright field and phase contrast), but without any staining, using standard light microscopy. For each collection, 30 measurements (× 1000 magnification) of conidia and other structures were made in water, with the extremes given in parentheses. Collections were deposited in the Mycological Herbarium of the Chifeng College, Inner Mongolia, China (“CFSZ”), the Mycological Herbarium of the Institute of Microbiology, Academia Sinica, Beijing, China (HMAS) and the Herbarium of Martin-Luther-University, Halle (Saale), Germany (HAL).

Taxonomy

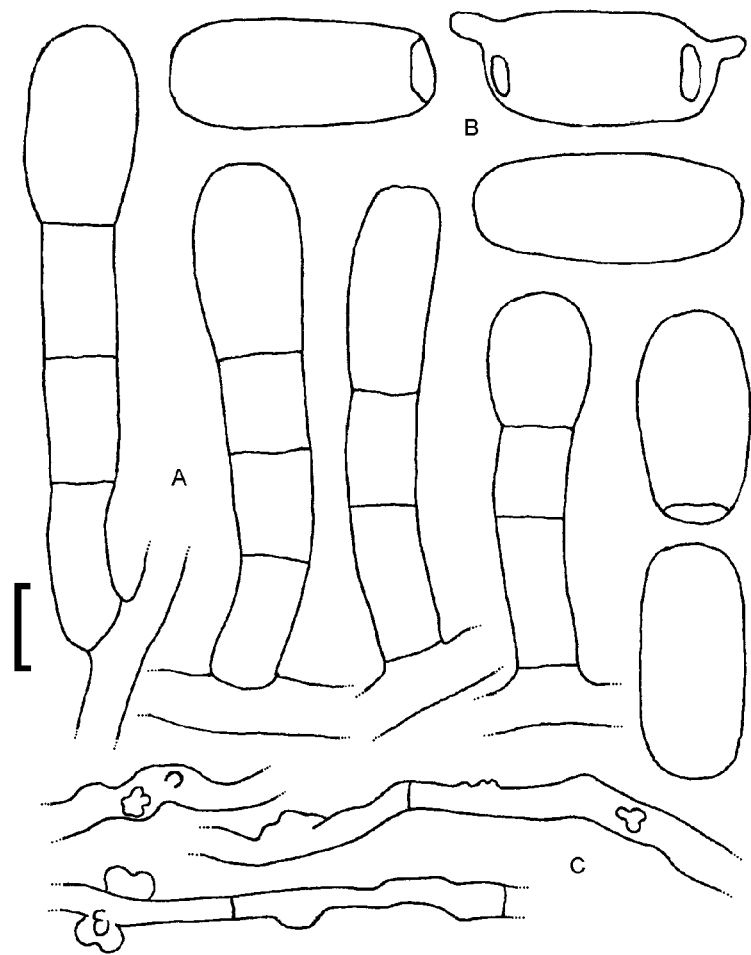


FIG. 1. *Erysiphe atraphaxis* var. *pluriappendicis*.
A. Conidiophores. B. Conidia. C. Hyphae with appressoria.
Scale bar = 10 µm. T.Z. Liu del.

(1) Reassessment of *Microsphaera atraphaxis* var. *pluriappendicis*

Erysiphe atraphaxis var. *pluriappendicis* (T.Z. Liu) T.Z. Liu & U. Braun,
comb. nov.

MYCOBANK MB 513090.

FIG. 1

BASIONYM: *Microsphaera atraphaxis* var. *pluriappendicis* T.Z.

Liu [as '*atraxaxidis*'], Mycosystema 22: 195, 2003.

SPECIMENS EXAMINED: CHINA. INNER MONGOLIA, Chifeng City, Hongshan District, Hongshan, on living leaves of *Atraphaxis manshurica* Kitag. (*Polygonaceae*), 24 Sep. 1995, T.Z. Liu (CFSZ 95122, HAL 2289 F, HMAS 74212); and 6 Oct. 2000, T.Z. Liu (CFSZ 00018); Chifeng City, Hexigten Banner, Darhan, 18 Jul. 2003, T.Z. Liu (CFSZ 03003).

COMMENTS: Based on current genus-level taxonomy of the *Erysiphaceae* (Braun et al. 2002), *Microsphaera atraphaxis* var. *pluriappendicis* must be transferred to the genus *Erysiphe* DC. Since the anamorph of *E. atraphaxis* var. *pluriappendicis* was not previously described in detail, the following supplementary description is given:

MYCELIUM amphigenous, effuse or forming thin white patches, subpersistent. HYPHAE 3–7 µm wide, hyaline or yellowish, smooth, thin-walled. APPRESSORIA lobed. CONIDIOPHORES erect, cylindrical, foot-cells straight, 16.5–36 × 7–13 µm, followed by 1–3 shorter cells. CONIDIA formed singly, doliiform-cylindrical or subcylindrical, surface rugose, (22–)29–38(–46) × 11–23 µm.

(2) Taxonomy of *Erysiphe bunkiniana* and *E. rabdosiae*

Erysiphe bunkiniana U. Braun, Feddes Repert. 91: 441, 1980.

FIG. 2

= *Erysiphe rabdosiae* R.Y. Zheng & G.Q. Chen, Sydowia 34: 276, 1981.

SPECIMENS EXAMINED: CHINA. INNER MONGOLIA, Chifeng City, Aohan Banner, Daheishan, on living leaves of *Rabdosia japonica* var. *glaucocalyx* (Maxim.) Hara (*Lamiaceae*), 11 Aug. 1996, T.Z. Liu (CFSZ 96010); Chifeng City, Bairin Left Banner, Yezhugou, 18 Aug. 2005, T.Z. Liu & Y.J. Gao (CFSZ 05023, HAL 1937 F); Chifeng City, Harqin Banner, Wangyedian, 14 Sep. 1995, T.Z. Liu, (CFSZ 95076); Chifeng City, Ningcheng County, Heilihe, 15 Sep. 1995, T.Z. Liu (CFSZ 95102); Chifeng City, Songshan District, Wushijiazi, 24 Sep. 1996, T.Z. Liu & X.W. Gao (CFSZ 96074); Tongliao City, Horqin Left Back Banner, Daqinggou, 31 Aug. 2003, T.Z. Liu & Q. Wen (CFSZ 03023).

COMMENTS: The anamorph of this species has been insufficiently known. The following supplementary description can be given:

MYCELIUM amphigenous, also cauligenous, forming distinct white patches, often occupying the whole leaf surface, persistent or subpersistent. HYPHAE 3–7 µm wide, hyaline or yellowish, smooth, thin-walled. Appressoria lobed. CONIDIOPHORES erect, (65–)90–176 µm long, foot-cells cylindrical, straight, (16.5–)38–64 × 6.5–11 µm, followed by 1–3(–4) shorter cells. CONIDIA formed singly, doliiform-cylindrical or subcylindrical, 20–36(–42) × 10–18(–20) µm.

There are five species of *Erysiphe* described from *Rabdosia* (= *Isodon*, *Plectranthus*) spp., viz. *E. bunkiniana*, *E. hommae* U. Braun, *E. huayinensis* R.Y. Zheng & G.Q. Chen, *E. rabdosiae* (Zheng & Chen 1981, Chen et al. 1987, Braun 1987, Nomura 1997), and *E. plectranthi* H.D. Shin & Y.J. La (Shin & La

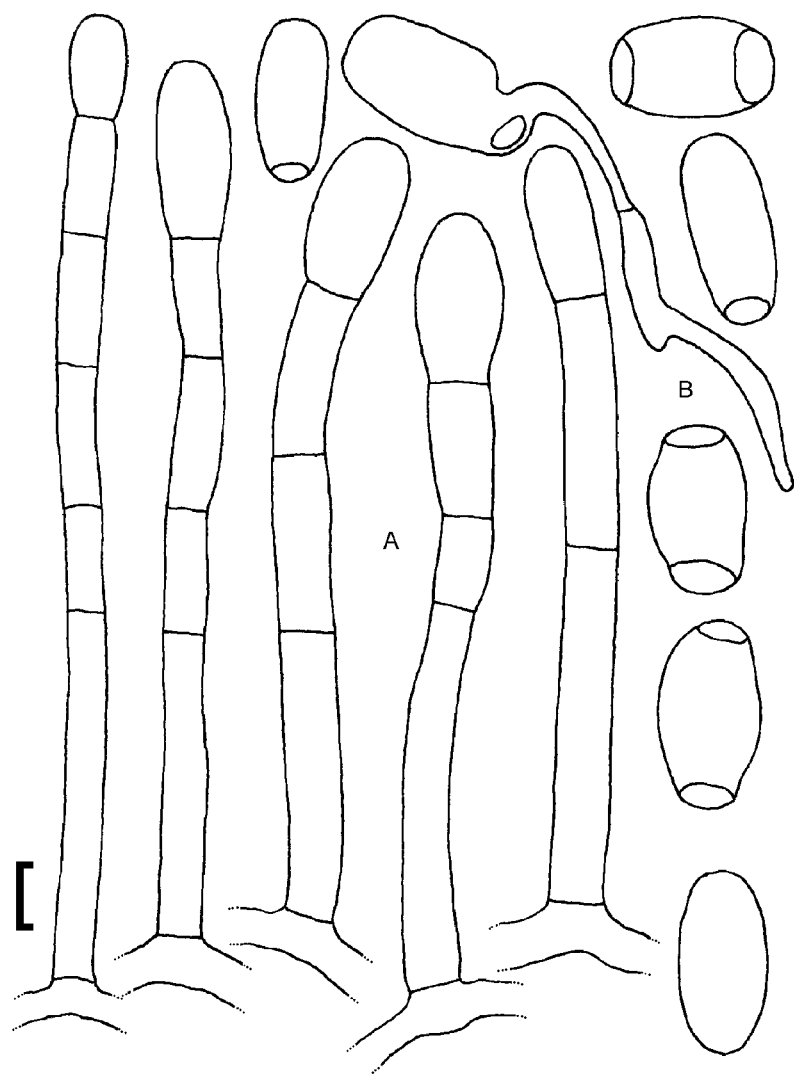


FIG. 2. *Erysiphe bunkiniana*. A. Conidiophores. B. Conidia.
Scale bar = 10 μ m. T.Z. Liu del.

1989, Shin 2000, Liu et al. 2007). *Erysiphe bunkiniana* and *E. rabdosiae*, two species characterized by forming chasmothecial appendages with somewhat pointed tips, previously were differentiated by the length of the appendages and number of ascospores. *Erysiphe bunkiniana* was described as forming relatively long appendages, (0.5–)2–3 times as long as the chasmothecial diameter, and asci with (5–)6–8 spores, whereas *E. rabdosiae* was discriminated by somewhat shorter appendages, not exceeding a relative length of 0.5–2 times the chasmothecial diameter, and (3–)4–6(–7)–spored asci. Within the six specimens collected in Inner Mongolia, several collections [incl. CFSZ 95076, 05023 (= HAL 1937 F)] are fully intermediate between *E. bunkiniana* and *E. rabdosiae*, i.e. young, short appendages fully agree with *E. rabdosiae* and older, longer ones rather coincide with those of *E. bunkiniana*. The whole range of the number of ascospores per ascus is also fully overlapping. Based on the

morphological continuum between powdery mildew collections on *Rabdosia* spp. previously referred to as *E. bunkiniana* and *E. rabdosiae*, it became evident that only different developmental stages of a single species have been involved. It is proposed to reduce *E. rabdosiae* to synonym with *E. bunkiniana*.

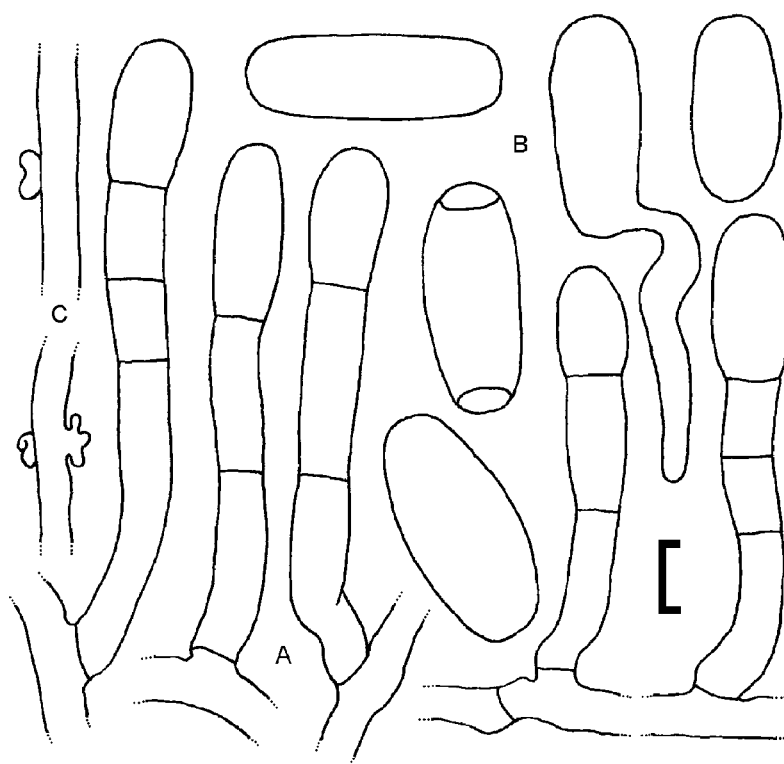


FIG. 3. *Erysiphe thermopsidis*. A. Conidiophores. B. Conidia. C. Hyphae with appressoria. Scale bar = 10 µm. T.Z. Liu del.

(3) Taxonomy of *Erysiphe thermopsidis* and *E. shinii*

Erysiphe thermopsidis R.Y. Zheng & G.Q. Chen, Sydowia 34: 287, 1981.

FIG. 3

= *Microsphaera thermopsidis* U. Braun, Mycotaxon 20: 491, 1984.

= *Erysiphe thermopsidis* (U. Braun) U. Braun & S. Takam. [as '*thermopsis*'],
Schlechtendalia 4: 14, 2000, non R.Y. Zheng & G.Q. Chen, 1981.

= *Erysiphe shinii* U. Braun & S. Takam., in Braun, Schlechtendalia 8: 34, 2002.

= *Trichocladia diffusa* f. *thermopsidis* Jacz., Karmannyj opredelitel'
gribov, Vyp. 2, Muchnisto-rosjannye griby: 316, Leningrad.

= *Microsphaera diffusa* var. *thermopsidis* (Jacz.) T.Z. Liu,
in Liu & Zhu, Mycosystema 17: 299, 1998.

SPECIMENS EXAMINED: CHINA. INNER MONGOLIA, Baotou City, Xilamuren, on living leaves of *Thermopsis lanceolata* R. Br. (Fabaceae), 29 Sep. 2004, T.Z. Liu, (CFSZ 04134); Chifeng City, Hongshan District, Nanshan, 13 Oct. 1994, T.Z. Liu & X.W. Gao (CFSZ 94027); 5 Nov. 1994, T.Z. Liu & X.W. Gao (CFSZ 94060); 5 Sep. 1995, T.Z. Liu (CFSZ 95036, HAL 2287 F); 2 Oct. 1995, T.Z. Liu (CFSZ 95145, HMAS 74213); Hohhot City, Zhaojun Mu, 25 Sep. 2004, T.Z. Liu (CFSZ 04103); Hulun Buir City, Hailar District, 2

Aug. 2006, T.Z. Liu (CFSZ 06033, HAL 2288 F); Ordus City, Dalad Banner, Engbei, 22 Sep. 2006, T.Z. Liu (CFSZ 06123, CFSZ 06127); Ordus City, Ejina Horo Banner, Qinggis Han's Mausoleum, 31 Aug. 1999, T.Z. Liu (CFSZ 99009); Ulanqab City, Tsining District, Laohushan, 16 Oct. 2005, T.Z. Liu (CFSZ 05373); Xilin Gol League, Plain Blue Banner, Herisutai, 19 Aug. 2005, T.Z. Liu & X.L. Bai (CFSZ 05038); Yihehaierhan, 21 Aug. 2005, T.Z. Liu & X.L. Bai (CFSZ 05059).

COMMENTS: The following supplementary description of the insufficiently known anamorph of this species is given:

MYCELIUM amphigenous, forming irregular white patches, eventually occupying the whole leaf surface, persistent. Hyphae 3–8 µm wide, hyaline. APPRESSORIA lobed. CONIDIOPHORES erect, foot-cells cylindrical, straight or slightly flexuous at the base, 23–50 × 7–10 µm, followed by 1–3 shorter cells. CONIDIA formed singly, doliiform, doliiform-cylindrical or cylindrical, surface rugose, (16.5–)23–33(–40) × 9–17 µm.

Zheng & Chen (Chen et al. 1987) discussed the differences between *Erysiphe thermopsidis* and *E. shinii* (= *Microsphaera thermopsidis*) in detail. Differentiation of the two species was based mainly on the length and morphology of the appendages. 13 powdery mildew specimens on *Thermopsis lanceolata* have been collected from different localities of Inner Mongolia. Most collections represent the *Erysiphe shinii* (= *Microsphaera thermopsidis*) type, i.e. they are characterized by having relatively long, often terminally branched chasmothecial appendages. However, even in these specimens long and branched appendages are mixed with short, unbranched ones, agreeing with those described for *Erysiphe thermopsidis*. Only three collections, viz. CFSZ 05038, 05059 and 06033 (= HAL 2288 F), represent the *E. thermopsidis* type, although some longer, 1–2(–3) times dichotomously branched, *E. shinii*-like appendages have also been observed. Furthermore, there are no distinct differences in the anamorphs of *E. shinii*- and *E. thermopsidis*-like collections. Therefore, it can be concluded that *E. thermopsidis* was based on immature, not yet fully developed, samples. The two morphological types represent two extremes of a morphological continuum within the variation of a single species. Therefore, it is proposed to merge the two species under the older valid name *E. thermopsidis*.

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We are much obliged to D.A. Glawe, Washington State University and University of Washington, USA and H.D. Shin, Korea University, College of Life Sciences and Biotechnology, Division of Environmental Science and Ecological Engineering, Seoul, Korea, for their pre-submission reviews. This study was supported by the Natural Science Foundation of the Inner Mongolia Autonomous Region of China (No 20080404Zd11).

Literature cited

- Braun U. 1987. A monograph of the *Erysiphales* (powdery mildews). Nova Hedwigia, Beiheft 89: 1–700.
- Braun U. 1999. Some critical notes on the classification and the generic concept of the *Erysiphaceae*. Schlechtendalia 3: 48–54.
- Braun U, Takamatsu S. 2000. Phylogeny of *Erysiphe*, *Microsphaera*, *Uncinula* (*Erysipheae*) and *Cystotheca*, *Podosphaera*, *Sphaerotheca* (*Cystothecaceae*) inferred from rDNA ITS sequences – some taxonomic consequences. Schlechtendalia 4: 1–33.
- Braun U, Cook RTA, Inman AJ, Shin H-D. 2002. The taxonomy of the powdery mildew fungi. 13–54, in R Bélanger et al. (eds.): The powdery mildews: a comprehensive treatise. St. Paul, APS Press.
- Chen GQ, Han SJ, Lai YQ, Yu YN, Zheng RY, Zhao ZY. 1987. Flora fungorum sinicorum. Vol. 1 (*Erysiphales*). Beijing, Science Press. (in Chinese).
- Liu TZ. 2007. Studies on taxonomy and flora of powdery mildews (*Erysiphaceae*) in Inner Mongolia, China. Chinese Doctoral Dissertations Full-text Database, Basic Sciences. 6, A006-49-1-255. (in Chinese).
- Liu TZ, Braun U. 2006. A new species of *Erysiphe* sect. *Microsphaera* from Inner Mongolia, China. Nova Hedwigia 83: 493–497.
- Liu TZ, Shang YZ. 2008. *Erysiphe alashanensis* sp. nov. from Inner Mongolia, China. Nova Hedwigia 86: 255–258.
- Liu TZ, Bai XL, Wang YC. 2006. Four new records of powdery mildews from China. Mycosystema 25: 529–535. (in Chinese).
- Liu TZ, Bai XL, Wang YC, Braun U. 2007. A new species and two new records of *Erysiphe* emend. from China. Mycotaxon 99: 75–81.
- Nomura Y. 1997. Taxonomical study of *Erysiphaceae* of Japan. Tokyo, Yokendo LTD. (in Japanese).
- Shin HD, La YJ. 1989. Three new species of *Erysiphe* from Korea. Korean J. Pl. Pathol. 5: 178–184.
- Shin HD. 2000. *Erysiphaceae* of Korea. Suwon, National Institute of Agricultural Science and Technology.
- Zheng RY, Chen GQ. 1981. The genus *Erysiphe* in China. Sydowia 34: 214–327.

Supplementary notes on *Basidiopycnis hyalina* (*Basidiomycota*, *Atractiellales*) and its anamorph

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Abstract — Publications concerning the auricularioid and pycnidial basidiomycete *Basidiopycnis hyalina* and its anamorph are reviewed. The hyphomycetous anamorph of *Basidiopycnis hyalina* is considered identical with the recently proposed taxon *Basidiopycnides albertensis*. Study of a type specimen potentially related to this anamorph revealed a new synonym, *Botryonipha dubia* (= *Stilbella dubia*, = *Stilbum dubium*) for the discomycete *Neodasyscypha cerina*. *Basidiopycnis* and its anamorph are excluded from the coelomycetes. Complementary data are presented for the phylogenetic relationship between the coelomycetous genus *Chaetospermum* and the teleomorphic genus *Efibulobasidium* of the *Sebacinales*. Re-examination of another recently described pycnidial basidiomycete with auricularioid basidia, *Mycogelidium sinense*, revealed that conidiophores of a coelomycetous sooty mould with relationship to the *Capnodiales* had been mistaken for basidia.

Key words — *Conidiocarpus*, *Helotiales*, sooty moulds, ultrastructure

Introduction

Basidiopycnis hyalina Oberw. et al. is a minute basidiomycete with auricularioid basidia developing within a white, conical peridium. The anamorph is hyaline, synnematous and has annellidic conidiogenous cells and one-celled conidia. This fungus was found in bark beetle galleries and was described as a new genus and species by Oberwinkler et al. (2006). The passively released basidiospores and the slimy masses of conidia were considered adaptations for dispersal by bark beetles. Subsequently, three other publications appeared that relate in various ways to the description of *B. hyalina*. Hausner et al. (2008) treated the anamorph, Rungjindamai et al. (2008) treated the anamorph and teleomorph, and Zhuang & He (2007) described a new species, genus, and family of

teleomorphic basidiomycetes with auricularioid basidia formed within peridia. In our opinion, some of the results and conclusions in these three publications are incorrect or deserve more detailed analysis. The present paper discusses these issues and contains complementary notes to our publication (Oberwinkler et al. 2006). The present note presents new data and alternative interpretations of previously published data.

Basidiopycnis hyalina

In our description of *B. hyalina*, we did not propose a formal name for the anamorph stage because it can be connected with the teleomorph beyond any doubt. The available data was insufficient for the morphological distinction between this anamorph and similar anamorphs (for examples see Oberwinkler et al. 2006). Finally, for basidiomycetous anamorphs with known teleomorph connections, there is a long tradition of not naming the anamorph stages separately, exemplified by the pioneers Brefeld (1888) and Buller (1924), and predominantly maintained in recent times in papers such as Botha & Eicker (1991), Frieders & McLaughlin (2001), Scheuer et al. (2008), Walther & Weiß (2006).

Another reason for not adding a second formal name to a single species was that the identity of several species mainly described in the 19th and beginning 20th century in *Botryonipha* Preuss, *Graphium* Corda, *Stilbella* Lindau, and *Stilbum* Tode has not been clarified, for example because type specimens could not be accurately reassigned or were not found (Seifert 1985). One of these doubtful *Stilbum* species, *Stilbum erythrinae* Hansf., was recently provisionally transferred to *Chionosphaera* D.E. Cox after study of the type (Kirschner & Chen 2008). For some of the other species, e.g. *Graphium claviforme* (“*clavaeforme*”) Preuss, Seifert (1985) mentioned a similarity with the anamorph of *Stilbotulasnella* Oberw. & Bandoni, which is presently morphologically indistinguishable from the anamorph of *Basidiopycnis hyalina* at the generic level (Oberwinkler et al. 2006).

In our attempts to trace back some of the unclear species of Seifert (1985), *Botryonipha dubia* was re-examined and excluded as a possible name for the anamorph of *Basidiopycnis hyalina*. The type specimen of *Graphium claviforme* was misplaced in B and could not be located and studied.

Neodasyscypha cerina (Pers. : Fr.) Spooner, in Suková, Czech Mycol. 57: 168, 2005

= *Botryonipha dubia* Preuss, Linnaea 25: 741, 1852; holotype,

Preuss 624 (= 548 b), B 70 0014109!, **syn. nov.**

≡ *Stilbum dubium* (Preuss) Sacc., Syll. Fung. 4: 575, 1886

≡ *Stilbella dubia* (Preuss) Lindau, Nat. Pflanzenfam. (Leipzig) 1(1**): 489, 1900

For further synonyms see Suková (2005).

COMMENTS: Several ascomycetes were found in the type specimen of *Botryonipha dubia* but the morphology of only one species conformed to the description of Preuss (1852). This species was represented by young stalked ascomata, with the apex densely covered with olive-yellowish hairs when seen with the dissecting microscope. In the light microscope, the hairs appeared brown, septate, thick-walled, and densely covered with warts of different sizes, which are considered the diagnostic characteristics for the genus *Neodasyscypha* Suková & Spooner (Suková 2005). Asci (approx. $50 \times 4 \mu\text{m}$) with a blue apical apparatus in Melzer's reagent and ellipsoidal to slightly fusoid ascospores ($5\text{--}6 \times 2 \mu\text{m}$) also supported the identification of *B. dubia* as young ascomata of *N. cerina*. The warts were apparently mistaken by Preuss (1852) for conidia and the hairs for conidiophores ("fibrillis septatis, longis, sporidiferis"). This new heterotypic synonym and its corresponding homotypic synonyms are additions to the curious history of nomenclature of this species (Suková 2005).

Hausner et al. (2008) made an important contribution to the knowledge of the anamorph of *Basidiopycnis hyalina* with their first published record from America. However, because they did not find the teleomorph, the species could be identified only in its anamorph by a combination of light microscopic and molecular sequence comparisons. The light microscopic characteristics were identical to those presented by Oberwinkler et al. (2006). The authors emphasized the spaces between the annellations of the conidiogenous cell visible by light microscopy, which are described differently by Hausner et al. (2008) and Oberwinkler et al. (2006). The minor differences can be explained easily. Fresh material was used for characterizing the annellidic conidiogenous cells in Hausner et al. (2008), but Oberwinkler et al. (2006) employed dried specimens. For illustrating the general identity of the morphology of conidiogenous cells, we reproduce here (FIG. 1) illustrations based on fresh material from Kirschner (1994). In Hausner et al. (2008), the ultrastructural differences between the anamorph of *B. hyalina* and similar anamorphs were taken from the literature. The status of previously described species of uncertain identity, mentioned above, was not addressed by Hausner et al. (2008).

Although no new data for distinguishing the anamorph of *B. hyalina* from similar anamorphs were presented by Hausner et al. (2008), they formally proposed a new genus and species, *Basidiopycnides albertensis*, for the anamorph of *B. hyalina*. The only differences between the American and European strains found by these authors were 3 substitutions in the 18S rDNA sequence and 16 substitutions in the complete ITS sequence. Because the ITS sequences compared are 405 bp long, this makes a 3.9% overall difference. For the American strains, five isolates from the same locality were used, two originating from the same substrate and therefore possibly genetically identical. As shown by Nilsson et al. (2008), intraspecific variability of ITS sequences

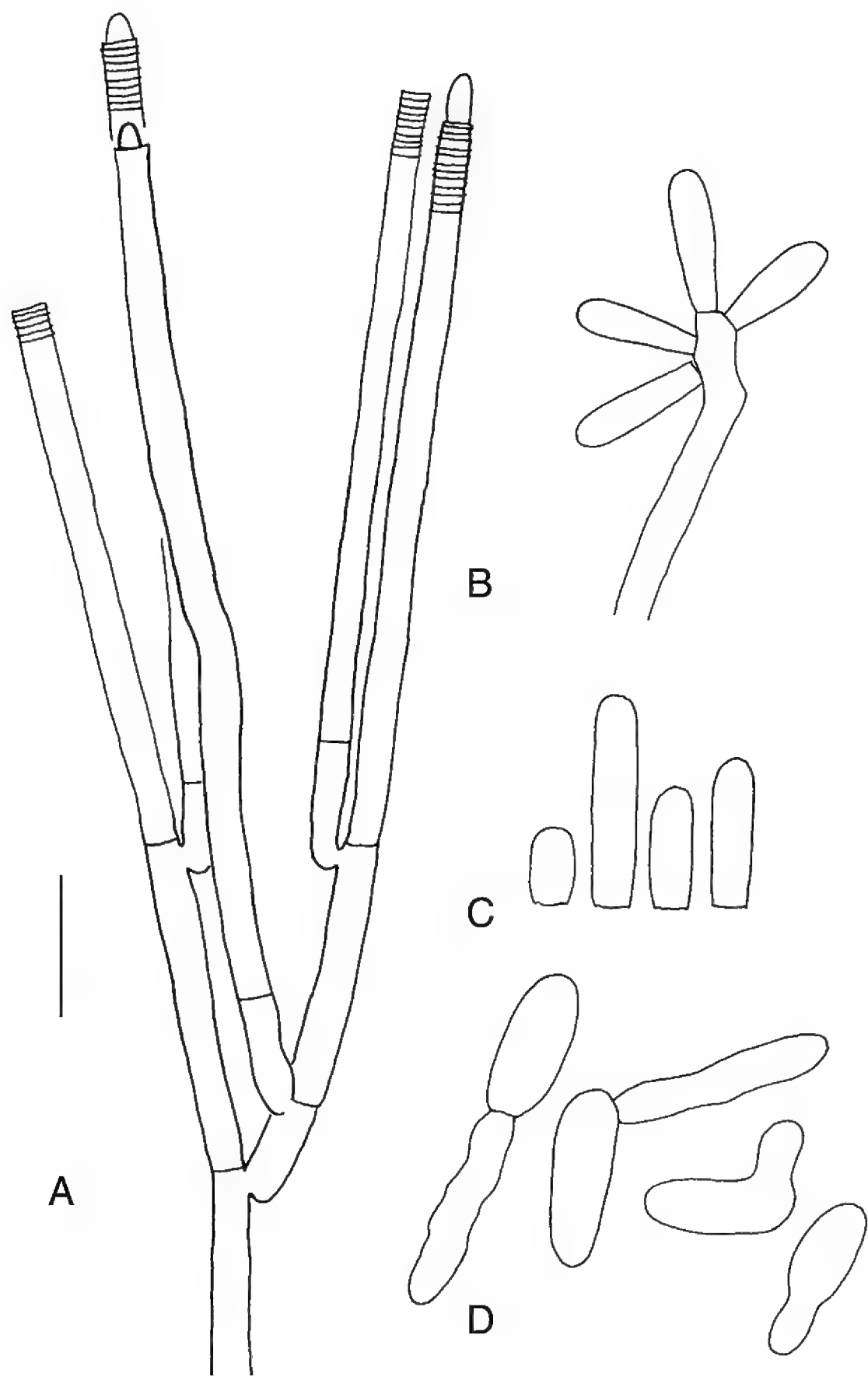


FIG. 1. *Basidiopycnis hyalina*, anamorph from living culture (reproduced from Kirschner 1994). Scale bar = 10 μ m. A. Conidiophore with individual annellations. B. Apex of an atypical conidiogenous cell from nutrient-rich medium with conidia still attached. C. Conidia. D. Germinating conidia.

can vary between 0 to 17.3%, and therefore the 3% threshold applied by some authors cannot be generalized for all fungal species. The systematic significance of different ITS positions within morphologically identical specimens can, therefore, be evaluated only when a significant number of strains from different geographical areas are compared. Since this is not the case for *B. hyalina* and its anamorph, we consider that the specimens from Europe and America represent a single species, with *Basidiopycnis hyalina* as teleomorph and *Basidiopycnides albertensis* as its anamorph. Studies of hitherto not clarified type specimens and of similar anamorphs are still necessary for adequate morphological characterization of the anamorph. More strains from other regions than those presently available will be required for reliable molecular analyses of species delimitations.

Basidiomycetous, but not all coelomycetous

Rungjindamai et al. (2008), in treating several anamorphic *Basidiomycota* with a molecular approach, showed phylogenetic relationships between certain coelomycetes and sexual basidiomycetes. The authors, however, confused hyphomycetes, coelomycetes, and basidiomycetes. *Basidiopycnis hyalina* (“*Basidiopycnis hyaline*”), *Helicogloea angustispora* L.S. Olive, and *Leucogloea compressa* (Ellis & Everh.) R. Kirschner are listed among “basidiomycete genera... with coelomycetous anamorphs” in the text and a table. The anamorphs of *B. hyalina* and *Helicogloea angustispora* and the anamorph species *L. compressa* are hyphomycetes, however, not coelomycetes. We admit that our naming of “*Basidiopycnis*” among “pycnidial members of the *Atractiellales*” (Oberwinkler et al. 2006) might be responsible for the connection of the teleomorph to the coelomycetes by Rungjindamai et al. (2008). Circumscribing this teleomorph genus and species as “gasteromycete”, i.e. in a purely morphological sense referring to basidia developing within a peridium, would avoid an affiliation with anamorphic coelomycetes more effectively than using the term “pycnidial members”. In the list of coelomycetes with relationships to basidiomycetes in Rungjindamai et al. (2008), *Leucogloea compressa* is given as teleomorph of *Pleurocolla compressa* (Ellis & Everh.) Diehl, but in fact both names are homotypic synonyms of the same anamorph. Furthermore, the pycnidial *Ditangium* P. Karst. anamorphs of *Craterocolla* Bref. species, also belonging to the *Sebacinales* (Brefeld 1888, Weiß et al. 2004), were not listed.

Rungjindamai et al. (2008) showed a phylogenetic relationship between species of the coelomycete genus *Chaetospermum* Sacc. and the *Sebacinales*. A connection between *Chaetospermum* and a known teleomorphic genus of the *Sebacinales* could not be suggested. Unfortunately, the authors were unaware of the note by Wells & Bandoni (2001), who recorded a *Chaetospermum* state in cultures of *Efibulobasidium albescens* (Sacc. & Malbr.) K. Wells. We can

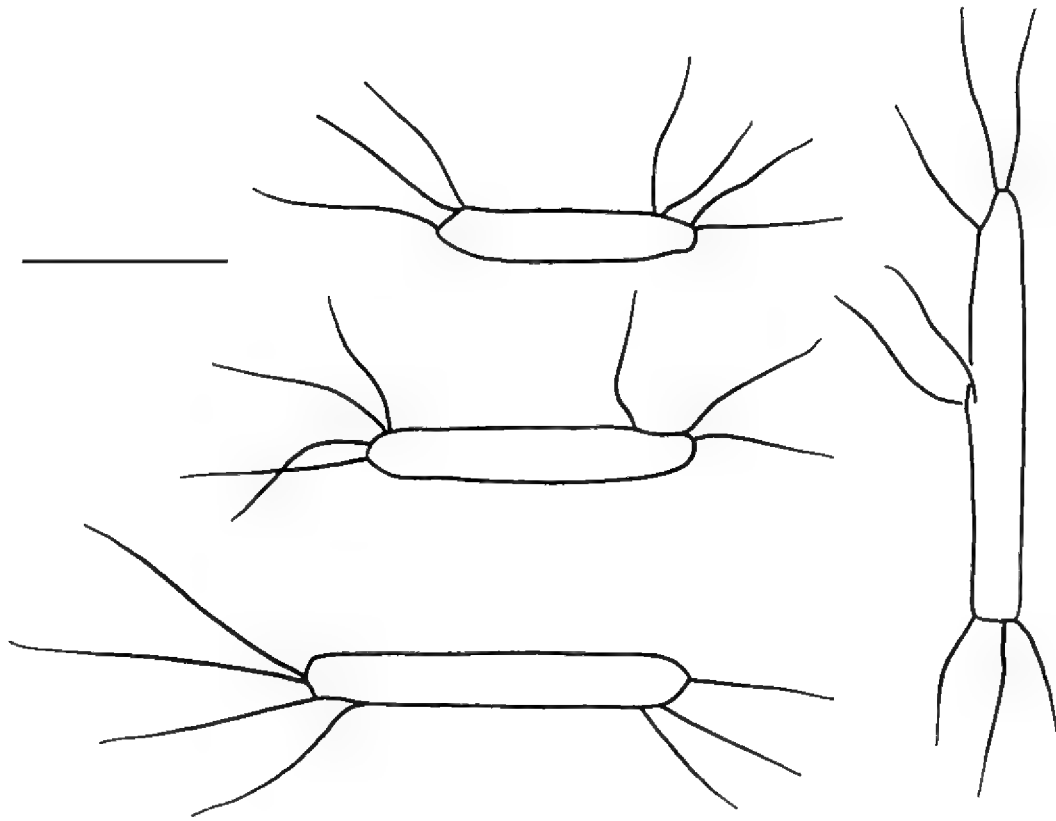


FIG. 2. Conidia of *Chaetospermum gossypinum* derived from cultivating *Efibulobasidium albescens* (R. Kirschner & C.-J. Chen 1316, TNM). Scale bar = 20 μm .

indirectly support this connection of *Chaetospermum* with the *Sebacinales* first shown by Wells & Bandoni (2001) with observations on *Ch. chaetosporum* (Pat.) A.L. Sm. & Ramsb. and *E. albescens*. Both are the type species of their respective genera, but were not included in the analyses by Rungjindamai et al. (2008). Our observations were based on material collected in Taiwan: *Chaetospermum chaetosporum*, on dead herbaceous stem, Taiwan, Hsinchu County, between Chutong and Guanwu Park, ca. 1,250 m, 3 Mar 2002, R. Kirschner & C.-J. Chen 1097; *Efibulobasidium albescens*, on dead twig, Taiwan, Chiayi County, Alishan, ca. 1,500 m, 8 June 2002, R. Kirschner & C.-J. Chen 1316 (TNM), a living culture could not be preserved, but a permanent slide of conidia from culture was saved (TNM). On the specimen of *E. albescens*, we found basidiospores of *E. albescens* together with conidia of *Chaetospermum gossypinum* (G.F. Atk.) Nag Raj in the same fructifications. In a pure culture of *Ch. gossypinum* derived from this material (R. Kirschner & C.-J. Chen 1316), conidia measured (24–) 25.5–37.5(–46) \times 4–5(–6) μm and had 3–4 polar and subpolar filamentous appendages, in some cases with additional, more lateral appendages (FIG. 2). Furthermore, we found dolipore septa with continuous parenthesomes typical of *Sebacinales* (and only few other basidiomycetous lineages) in *Ch. chaetosporum* collected in the field (R. Kirschner & C.-J. Chen 1097; FIG. 3). Identification of *Chaetospermum* species without re-examination of types remains tentative according to Nag Raj (1993). More detailed investigation of the morphology of

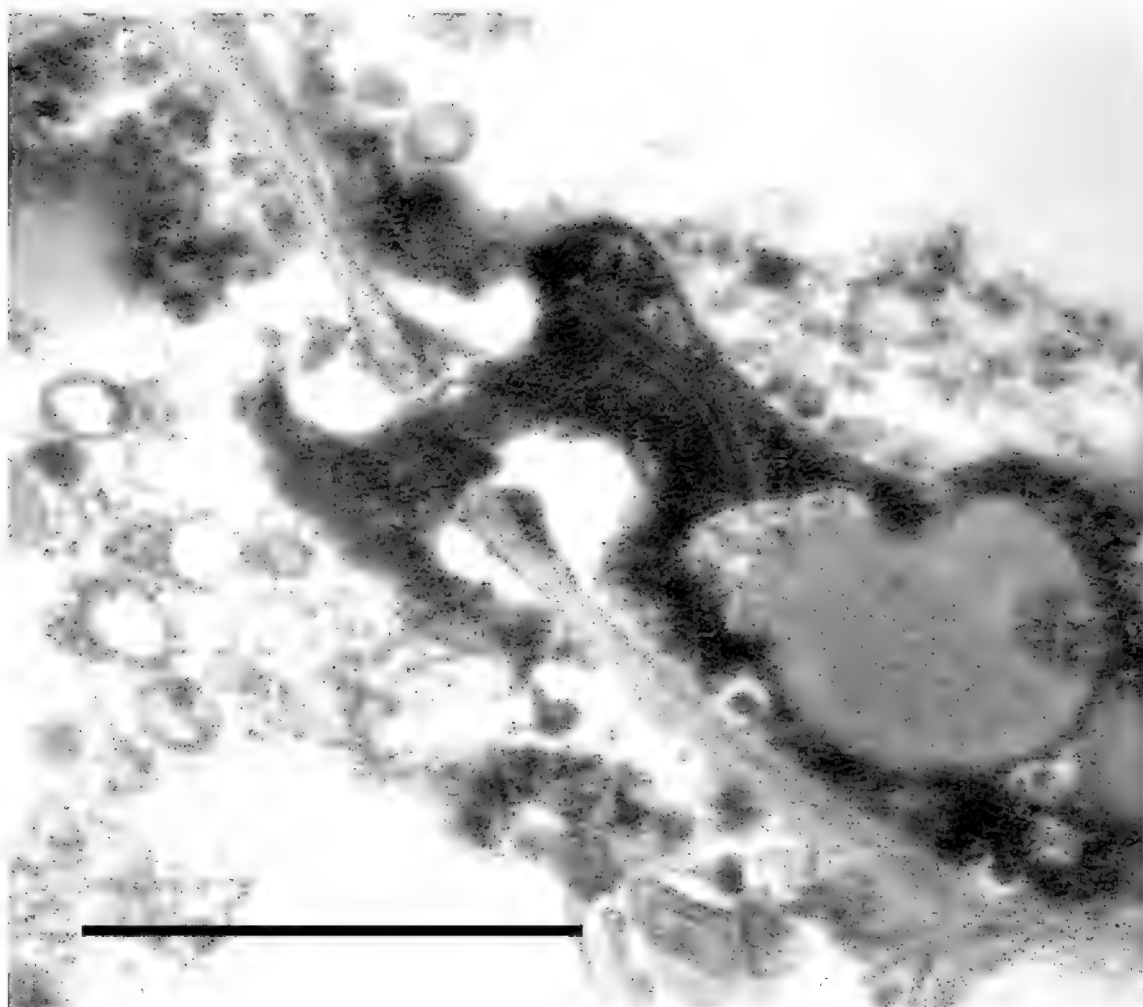


FIG. 3. Ultrastructure of hyphal septum of *Chaetospermum chaetosporum* (R. Kirschner & C.-J. Chen 1097, TNM) showing a dolipore with a continuous parenthesome (the other parenthesome hardly visible probably due to bad fixation). Scale bar = 0.5 μ m.

Efibulobasidium species in culture and molecular analyses including the type species of *Chaetospermum* and *Efibulobasidium* will contribute to a clarification of the anamorph-teleomorph relationship.

Coelomycetous, but not basidiomycetous

Zhuang & He (2007) published a new family, *Mycogelidiaceae* W.Y. Zhuang based on a new genus and species from China, *Mycogelidium sinense* W.Y. Zhuang & X.S. He. Pigmented pycnidia are formed on large, strongly branched coralloid thalli, several cm broad. Four-celled, transversally septate hyphae giving rise to spores on peg-like outgrowths in the pycnidia were interpreted as auricularioid basidia. The illustrations of the fructification composed of pycnidia partly embedded in branched, sterile stalks, however, indicate a relationship to coelomycetous sooty mould genera such as *Conidiocarpus* Woron., *Conidioxyphium* Bat. & Cif., and *Podoxyphium* Speg., which are pycnidial anamorphs of *Capnodiales*, *Ascomycota* (Batista & Ciferri 1963, Hughes 1976). These anamorphs are reported to attain dimensions of several

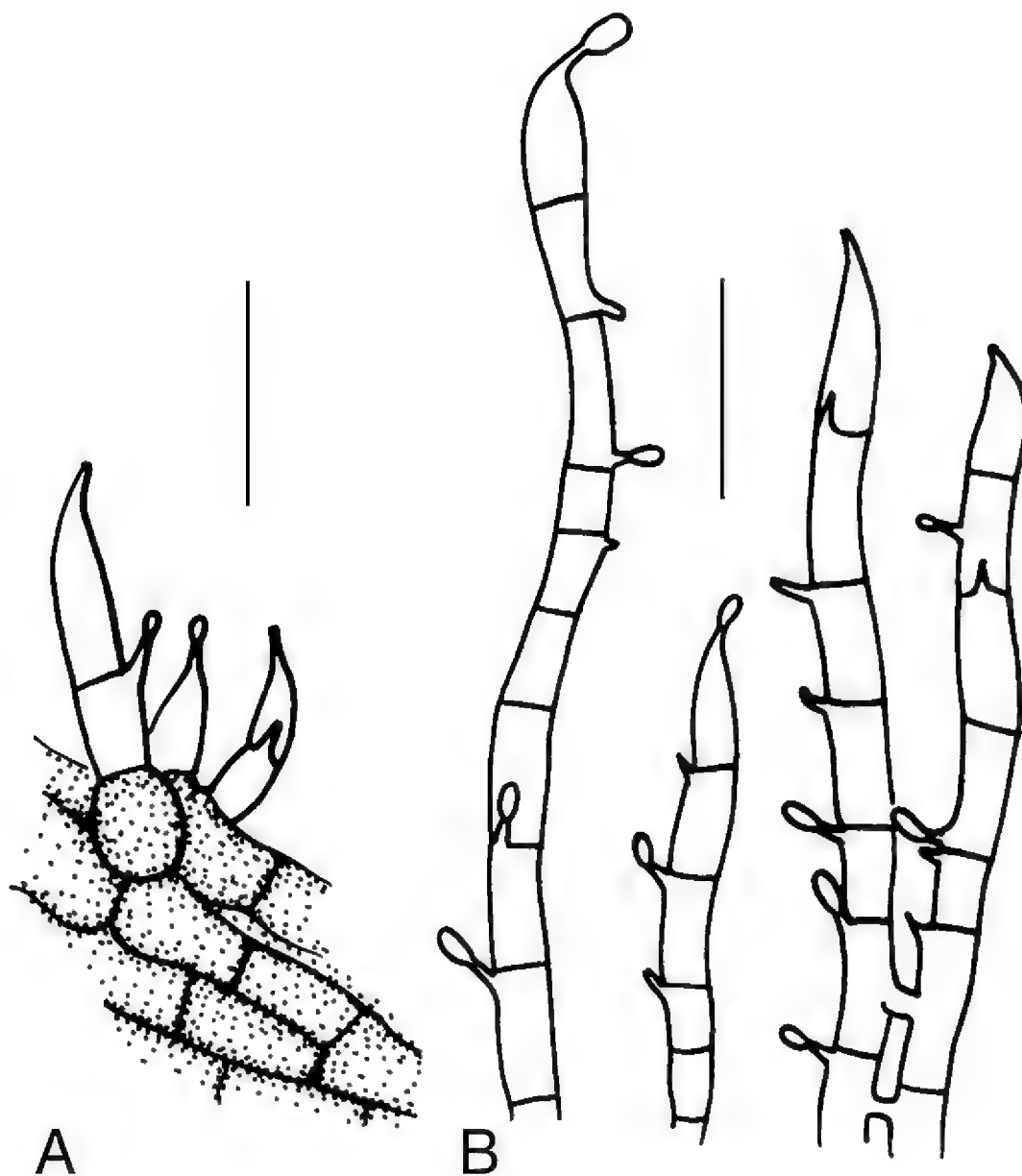


FIG. 4. *Mycogelidium sinense*, conidiophores from isotype (HMAS 97522), squash mount in 5% KOH and 1% aqueous phloxine, observed with phase contrast. A. One- and two-celled conidiophores arising from the pycnidial wall. B. Several-celled conidiophores. Scale bar = 10 μ m.

mm (Batista & Ciferri 1963), which are even exceeded by the Chinese specimens. Re-examination of the isotype of *M. sinense* (HMAS 97522) revealed that the dark pigmented pycnidia often show a slight swelling above the terminal sterile, pale brown branch. The original description of auricularioid basidia was based on a misinterpretation of conidiophores with intercalary conidiogenous cells. We found 1- to 9-celled conidiophores directly arising from the pale brown inner wall of the venter-like pycnidial cavity, $4\text{--}46 \times 2\text{--}3 \mu\text{m}$, with individual conidiogenous cells, $3\text{--}8 \times 2\text{--}3 \mu\text{m}$, and a terminal, subterminal, basal, rarely lateral conidiogenous outgrowth per cell, $1\text{--}2 \times 0.5 \mu\text{m}$ (FIG. 4). The apical point of these outgrowths was too minute to resolve any periclinal thickening or

annellidic wall structures with the light microscope. The family *Mycogelidiaceae* is considered an anamorphic family name corresponding to the *Capnodiaceae*. The habit of conidiomata and micromorphology of conidiophores and conidia indicate a relationship of *Mycogelidium sinense* to *Conidioxyphium* in the sense of Sutton (1980). *Conidioxyphium* and *Podoxyphium* were considered synonyms of *Conidiocarpus* by Hughes (1976). *Mycogelidium* is probably a synonym of *Conidiocarpus* in the sense of Hughes (1976). The invalid family “*Asbolisiaceae* Speg. char. em. Bat. & Ciff. (1963)” comprising capnodiaceous pycnidial fungi (Hughes 1976) corresponds to the *Mycogelidiaceae*. The pycnidial fungi mentioned here are generally connected to sexual *Capnodiaceae*, but details have not been sufficiently clarified (Hughes 1976). Though the generic delimitations of coelomycetous sooty moulds connected to the *Capnodiaceae* and related families were examined by Hughes (1976) and Sutton (1980), delimitations particularly at the species level are still very difficult and need a revision based on type studies, cultivation, and molecular approaches. At the present time, we cannot draw any taxonomical conclusions on *Mycogelidium sinense* and do not preclude eventual recognition of this taxon as a separate species or even genus, especially because of the unusually large fructifications.

Acknowledgments

We thank Chee-Jen Chen for help in collecting specimens in Taiwan, Martina Reblová for inspiring discussions on the identity of *Botryonipha dubia*, and M. Stöhr and S. Späthe for technical assistance with TEM. The curators of HMAS and B are thanked for loaning type specimens. We are especially grateful to Chee-Jen Chen and José Paulo Sampaio for their pre-review of the manuscript, and to Keith A. Seifert for critically reading the English text.

Literature cited

- Batista A, Chaves, Ciferri R. 1963. The sooty-molds of the family *Asbolisiaceae*. Quaderno. Laboratorio Crittogamico, Istituto Botanico della Università di Pavia 31 (Publ. Istituto di Micologia Universidade do Recife 163): 1–229.
- Botha WJ, Eicker A. 1991. Cultural studies on the genus *Termitomyces* in South Africa. I. Macro- and microscopic characters of basidiome context cultures. Mycol. Res. 95: 435–443.
- Brefeld O. 1888. Basidiomyceten. II. Protobasidiomyceten. Unters. Gesamtgeb. Mykol. 7: 1–178.
- Buller AHR. 1924. Researches on Fungi. III. The production and liberation of spores in *Hymenomycetes* and *Uredineae*. Hafner Publishing Co., New York. 611 pp.
- Frieders EM, McLaughlin DJ. 2001. The heterobasidiomycete moss parasites *Jola* and *Eocronartium* in culture: cytology, ultrastructure, and anamorph. Mycol. Res. 105: 734–744.
- Hausner G, Reid J, Eyjólfsson GG, Iranpour M, Lowen PC. 2008. *Basidiopycnides albertensis* gen. et sp. nov., a new anamorphic fungus with phylogenetic affinities in the *Atractiellales* (*Basidiomycota*). Mycotaxon 103: 279–297.
- Hughes SJ. 1976. Sooty moulds. Mycologia 68: 693–820.

- Kirschner R. 1994. Mit Borkenkäfern assoziierte Pilze. Diploma thesis, Faculty for Biology, University Tübingen, Germany. 148 pp.
- Kirschner R, Chen C-J. 2008. *Physalacria corticola*, *Physalacria stilboidea*, and *Stilbum vulgare*, three sphaeropedunculate *Basidiomycota* new to Taiwan, with notes on *Stilbum erythrinae*. Fungal Science 23: 51–61.
- Nag Raj TR. 1993. Coelomycetous anamorphs with appendage-bearing conidia. Mycologue Publications, Waterloo, Ontario, Canada. 1101 pp.
- Nilsson RH, Kristiansson E, Ryberg M, Hallenberg N, Larsson K-H. 2008. Intraspecific ITS variability in the kingdom *Fungi* as expressed in the international sequence databases and its implications for molecular species identification. Evolutionary Bioinformatics 4: 193–201.
- Oberwinkler F, Kirschner R, Arenal F, Villareal M, Rubio V, Begerow D, Bauer R. 2006. Two new pycnidial members of the *Atractiellales*: *Basidiopycnis hyalina* and *Proceropycnis pinicola*. Mycologia 98: 627–649.
- Preuss GT. 1852. Uebersicht untersuchter Pilze, besonders aus der Umgegend von Hoyerswerda. Linnaea 25: 723–742.
- Rungjindamai N, Skayaroj J, Plaingam N, Somrithipol S, Jones EBG. 2008. Putative basidiomycete teleomorphs and phylogenetic placement of the coelomycete genera: *Chaetospermum*, *Giulia* and *Mycotribulus* based on nu-rDNA sequences. Mycol. Res. 112: 802–810.
- Scheuer Ch, Bauer R, Lutz M, Stabentheiner E, Mel'nik VA, Grube M. 2008. *Bartheletia paradoxa* is a living fossil on *Ginkgo* leaf litter with a unique septal structure in the *Basidiomycota*. Mycol. Res. 112: 1265–1279.
- Seifert KA. 1985. A monography of *Stilbella* and some allied hyphomycetes. Studies in Mycology 27:1 –235.
- Suková M. 2005. A revision of selected material of lignicolous species of *Brunnipila*, *Capitotricha*, *Dasyscyphella* and *Neodasyscypha* from the Czech Republic. Czech Mycol. 57: 139–172.
- Sutton BC. 1980. The coelomycetes. CAB International, Oxon, UK. 696 pp.
- Walther G, Weiß M. 2006. Anamorphs of the *Bolbitiaceae* (*Basidiomycota*, *Agaricales*). Mycologia 98: 792–800.
- Weiß M, Selosse M-A, Rexer K-H, Urban A, Oberwinkler F. 2004. *Sebacinales*, a hitherto overlooked cosm of heterobasidiomycetes with a broad mycorrhizal potential. Mycol. Res. 108: 1003–1010.
- Wells K, Bandoni RJ. 2001. Heterobasidiomycetes. In: McLaughlin, DJ, EG McLaughlin, and PA Lemke (eds.): *The Mycota VII Part B*, pp. 85–120.
- Zhuang W-Y, He X-S. 2007. A new pycnidoid basidiomycete family with gelatinized fruitbodies. Mycosystema 26: 339–342.

A new species of *Lylea* (hyphomycetes) on *Rhopalostylis* (Arecaceae) in New Zealand

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Abstract—*Lylea rhopalostylidis* sp. nov., found on dead leaves of *Rhopalostylis sapida* in New Zealand, is illustrated and described and compared with related taxa.

Key words—anamorphic fungi, deuteromycetes, taxonomy

Introduction

The palm genus *Rhopalostylis* contains only two taxa: *R. baueri* (endemic to Norfolk Island and to Raoul Island, Kermadec Islands) and *R. sapida* (endemic to mainland New Zealand). Recently, while examining a dead leaf of *R. sapida* for saprobic fungi, a species of *Lylea* was found. It is morphologically distinct from any of the previously described species and is described below as a new species.

Materials and methods

Portions of leaf sheath from dead, fallen fronds of the endemic nikau palm (*Rhopalostylis sapida* H. Wendl. & Drude) were collected from a coastal grove. The plant material was incubated under humid conditions and periodically examined for sporulating microfungi. Fungal fruiting structures were removed, mounted in lactophenol, and examined by light microscopy. Measurements were made on material mounted in lactophenol. A dried herbarium specimen of the new fungus was prepared and is deposited in the New Zealand Fungal Herbarium (Herb. PDD). The species is known only from the holotype.

Taxonomy

The genus *Lylea* Morgan-Jones was described by Morgan-Jones (1975), for a single species, *L. catenulata* Morgan-Jones. Since then only two species have been added to the genus (Holubová-Jechová 1978, Mercado-Sierra et al. 1997). The

genus is characterised by the formation of catenate conidia from monoblastic conidiogenous cells. The conidia are usually cylindrical, or fusiform. They are distoseptate, a feature that separates the genus from euseptate genera such as *Heteroconium*, *Septonema*, and *Taeniolella*. Mercado-Sierra et al. (1997) provided a key to the species of *Lylea*.

A specimen collected on *Rhopalostylis sapida* in New Zealand is distinct from all other known species, and is described here.

***Lylea rhopalostylidis* McKenzie, sp. nov.**

FIG. 1

MYCOBANK: MB 512736

Coloniae pilosae. Mycelium ex hyphis in substrato externum et immersum, ramosis, septatis, laevibus, brunneis vel pallide brunneis, tenuitunicatis, 2.5–4 µm crassis compositum. Conidiophora macronematosa, mononematosa, solitaria, erecta, recta vel paulo flexuosa, nonramosa, laevia, 4–7-septata, brunnea, usque ad 90 µm longa, 4.5–6 µm lata, crassitunicata. Cellulae conidiogenae monoblasticae, in conidiophora incorporatae, terminales, determinatae, cylindricae, 5.5–15 µm longa. Conidia catenata, sicca, acrogena, brunnea, laevia, recta vel curvata, cylindrica vel obclavata, basi truncata, apice late rotundato, (2–)4–6(–10)-distoseptatis, constricta vel non constricta, (16.5–)30–45(–75) × 5.5–9(–10) µm.

ETYMOLOGY: named after the host substrate, *Rhopalostylis*.

TYPE: NEW ZEALAND, Auckland, Piha, North Piha Beach, start of White Track, 36° 56.50206'S, 174° 28.03919'E, in foliis mortuis areacearum *Rhopalostylis sapida* (Arecaceae), 27 October 2008, E.H.C. McKenzie, A. McKenzie (PDD 95060, holotype).

COLONIES in the form of scattered conidiophores. MYCELIUM superficial and immersed in the substratum. HYPHAE branched, septate, smooth, brown or pale brown, thick-walled, 2.5–4 µm diam. CONIDIOPHORES differentiated, mononematous, single, erect, straight or slightly flexuous, unbranched, smooth, 4–7-septate, brown, up to 90 µm long, 4.5–6 µm wide, thick-walled. CONIDIOGENOUS CELLS monoblastic, integrated, terminal, determinate, cylindrical, 5.5–15 µm long. CONIDIA in unbranched, acropetal chains, which separate readily, dry, acrogenous, brown, smooth, straight or curved, cylindrical or obclavate, base truncate, apex broadly rounded, (2–)4–6(–10)-distoseptate, often slightly constricted at one or more septa, (16.5–)30–45(–75) × 5.5–9(–10) µm (mean = 37.7 × 7.8 µm, n = 50). Mean of 2-septate conidia = 18.6 µm; 3-septate = 21.9 µm; 4-septate = 28.1 µm; 5-septate = 34.5 µm; 6-septate = 40.9 µm; 7-septate = 32.9 µm; 8-septate = 52.0 µm; 9-septate = 58.4 µm; 10-septate = 67.3 µm.

COMMENTS: The conidia of *Lylea rhopalostylidis* are morphologically similar to those of *L. catenulata* although those of the latter are somewhat longer ((18–)40–67(–120) µm) and are usually formed in branched chains (Morgan-Jones 1975). *L. catenulata* has cylindrical conidia with a smooth outline, rather than sometimes being constricted at the septa as in *L. rhopalostylidis*. The conidia of



FIG. 1. Conidia and conidiogenous cells of *Lylea rhopalostylidis* (from holotype). Specimen mounted in hydrous lactophenol. Scale bar = 20 μ m.

L. catenulata are rounded at both ends whereas those of *L. rhopalostylidis* are rounded at the apical end but usually truncate at the base. The conidiophores of *L. catenulata* are micronematous or semi-macronematous, being formed as “very short, erect, cylindrical branches of the superficial mycelium” (Morgan-Jones 1975); those of *L. rhopalostylidis* are distinct and long. Both of the other species, *L. palmicola* Mercado et al. and *L. tetracoila* (Corda) Hol.-Jech., produce conidia that are usually only 3-septate and are truncate at each end. The conidia of *L. palmicola* are much smaller ($6\text{--}18 \times 2.5\text{--}4\text{ }\mu\text{m}$, Mercado-Sierra 1997) than those of *L. rhopalostylidis*, while the conidia of *L. tetracoila* are generally a little longer and narrower, and are often fusiform.

Lylea rhopalostylidis is a saprobe on dead leaves of *Rhopalostylis sapida*. *L. palmicola* is known only on dead leaves of palms in Cuba and Mexico (Mercado-Sierra et al. 1997). *L. catenulata* was described as a saprobe on bark of dead twigs of *Pinus taeda* in USA (Morgan-Jones 1975). *L. tetracoila* (syn. *Heteroconium tetracoilum* (Corda) M.B. Ellis) is saprobic on rotten bark and wood of various trees including *Betula*, *Fagus*, *Fraxinus*, *Populus*, and *Quercus* and is also commonly found growing on or near old fructifications of

diatrypaceous fungi (Ellis 1976, Holubová-Jechová 1978). It has been recorded in Europe and North America (Ellis 1976).

A large number of fungi have been recorded from palms — especially the larger, woody palms — including approximately 400 species of hyphomycetes for which palm tissue is the type substrate (Taylor & Hyde 2003). McKenzie et al. (2004) noted that 147 named species of fungi and 50 species identified only to genus have been recorded on *Rhopalostylis* (mainly *R. sapida*) in New Zealand. Nine species of anamorphic fungi have been described with *R. sapida* as the type substrate and four of these are, so far, restricted to *R. sapida* (McKenzie et al. 2004, Braun et al. 2006).

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Literature cited

- Braun U, Hill CF, Schubert K. 2006. New species and new records of biotrophic micromycetes from Australia, Fiji, New Zealand and Thailand. *Fungal Diversity* 22: 13–35.
- Ellis MB. 1976. More dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, U.K. 507 pp.
- Holubová-Jechová V. 1978. Lignicolous hyphomycetes from Czechoslovakia 5. *Septonema*, *Hormiactella* and *Lylea*. *Folia Geobotanica et Phytotaxonomica* 13: 421–442.
- Mercado-Sierra A, Figueras MJ, Gené J. 1997. New or rare hyphomycetes from Cuba VIII. Species of *Lylea*, *Phaeoisaria*, *Arxiella*, *Graphium*, *Periconia* and *Ramichloridium*. *Mycotaxon* 63: 369–375.
- McKenzie EHC, Buchanan PK, Johnston PR. 2004. Checklist of fungi on nikau palm (*Rhopalostylis sapida* and *R. baueri* var. *cheesemanii*) in New Zealand. *New Zealand Journal of Botany* 42: 335–355.
- Morgan-Jones G. 1975. Notes on hyphomycetes. VIII. *Lylea*, a new genus. *Mycotaxon* 3: 129–132.
- Taylor JE, Hyde KD. 2003. Microfungi of tropical and temperate palms. *Fungal Diversity Research Series* 12.

Two new species of *Acanthothecis* (lichenized Ascomycota) from Brazil

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Abstract – *Acanthothecis kalbii* and *Acanthothecis pruinocarpa* are described as new species.

Key words – lichens, *Graphidaceae*, restinga, Paraná

Introduction

Acanthothecis Clem. is a genus of about 28 species (Staiger & Kalb 1999, Staiger 2002, Makhija & Adawadkar 2003, 2007; Archer 2006, 2007; Archer & Elix 2007, 2008) with a pantropical-subtropical distribution (Lücking & Rivas-Plata 2008). The genus is represented in Brazil by 11 species, eight of which were described from Brazilian material.

Acanthothecis is characterized by the presence of spiny paraphyses tips and/or periphysoids in combination with oval to oblong ascomata, uncarbonized to slightly carbonized exciples, entire to striate labia, and mostly clear hymenia. The ascospores are trans-septate to muriform, mostly I–, oblong and with a thin cell wall (Staiger & Kalb 1999, Lücking & Rivas-Plata 2008).

Materials and methods

The new species were described from specimens collected in restinga, which is typical Brazilian coastal vegetation, in Paraná State, Southern Brazil. The specimens were examined using standard stereoscopic and light microscopic examination. Sections of thalli and ascomata were mounted in water, 10% KOH and Lugol's Solution. All measurements were made in water. Chemical constituents were identified by thin layer chromatography (Culberson & Ammann 1979, Elix & Ernst-Russell 1993) and by comparison with authentic samples.

Taxonomic description

Acanthothecis kalbii Dal-Forno & Eliasaro, sp. nov.

FIG. 1

MYCOBANK 512983

Differt ab A. nivalis quia offert lirellas breviores, non prominentes, discum expositum et acidum norsticticum.

TYPE: BRAZIL. PARANÁ: Pontal do Paraná. PONTAL DO SUL, 28.II.2008, S25°34'02.2" W48°22'01.8", M. Dal-Forno 518 (Holotype–UPCB).

ETYMOLOGY: The new species is named in honour of Dr. Klaus Kalb, from Lichenologisches Institut Neumarkt, Neumarkt, Germany.

Thallus corticolous, epiperidermal, 15–40 µm thick, continuous, with few crystals; surface smooth, corticate, dull, off-white. Ascoma lirelliform, concolorous with the thallus, immersed to erumpent, 0.3–0.5(–0.9) mm long, 0.15–0.25 mm wide, with conspicuous lateral thalline margin; disc exposed, pale grey white pruinose; labia entire, convergent; excipulum uncarbonized, poorly developed, 100 µm high, 15–20 µm thick, pale yellow. Hymenium clear, 50–60 µm high, 170–180 µm wide, hyaline, I–; epithecium pale brown, 5.0 µm high; hypothecium hyaline, 5.0 µm high; paraphyses unbranched, filiform, 1.0 µm thick, with spiny tips, hyaline; periphysoids unbranched, spiny, 10–20 µm long, 1.0–4.0 µm thick, hyaline; asci ellipsoid, 40–45 × 7–10 µm; ascospores 8 per ascus, hyaline, I–, ellipsoid, transversely 3–5-septate, 9–15 µm long, 4–5 µm wide, with thin cell wall and jelly-like halo.

CHEMISTRY: thallus K+ yellow-red (forming red crystals in microscope sections), norstictic acid present.

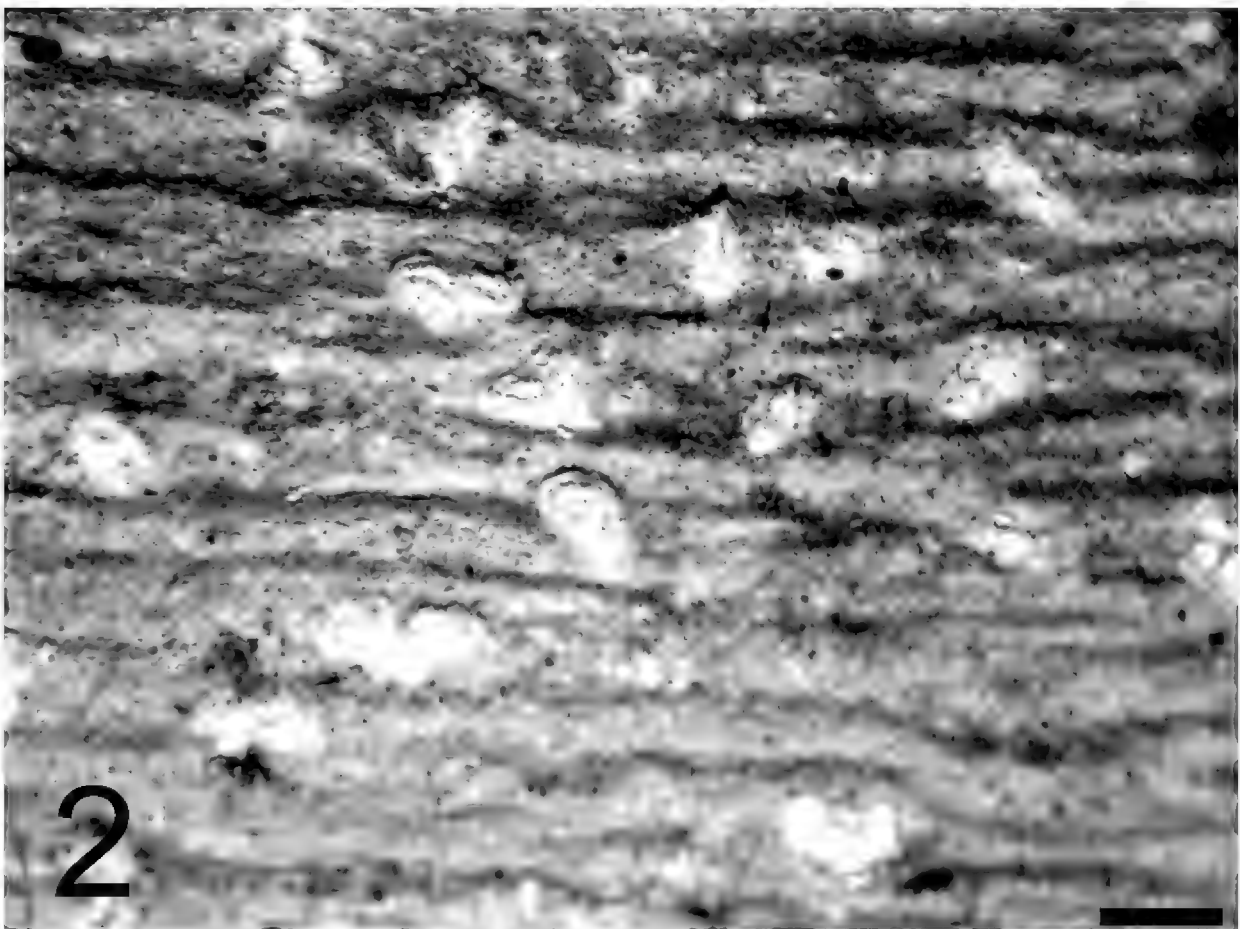
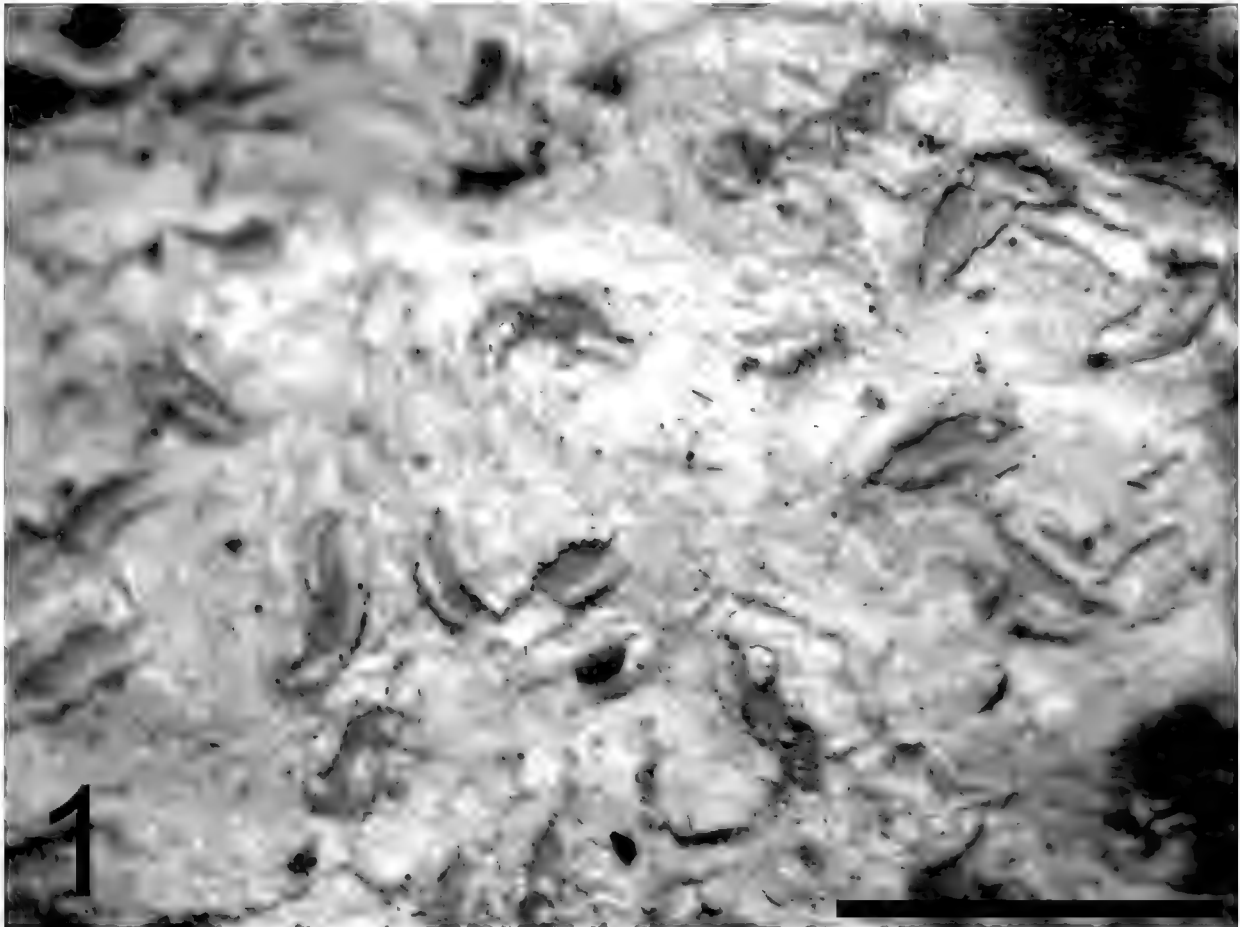
ADDITIONAL SPECIMENS EXAMINED – BRAZIL. PARANÁ: Pontal do Paraná. PONTAL DO SUL, 28.II.2008, S25°34'11.1" W48°21'32.4" M. Dal-Forno 491, 496b (UPCB).

COMMENTS – *Acanthothecis kalbii* is characterized by the oblong lirellae, with grey white pruinose discs, spiny paraphyses-tips and periphysoids, an uncarbonized excipulum, hyaline ascospores, I–, transversely 3–5-septate, 9–15 × 4–5 µm, and the presence of norstictic acid.

Acanthothecis nivalis Makhija & Adaw. shares some characteristics with *A. kalbii*, such as size and septation of ascospores and spiny paraphyses-tips and periphysoids. However, *A. nivalis* has prominent and longer (2–8 mm) lirellae, concealed discs, and psoromic acid (K–).

Acanthothecis kalbii resembles the saxicolous species *A. silicicola* (Redinger) Staiger & Kalb in size and septation of ascospores and presence of norstictic acid. However *A. silicicola* does not show the distinct spiny paraphyses-tips and periphysoids, present in *A. kalbii*.

Staiger & Kalb (1999) mentioned three *Acanthothecis* species that were well distinguished from other known *Acanthothecis* species but did not describe them as new for science because the material was too scarce. *Acanthothecis*



FIGURES 1–2: *Acanthothecis* species. 1: *A. kalbii* (holotype, UPCB); 2: *A. pruinocarpa* (holotype, UPCB); bars = 1mm.

kalbii closely resemble one of them, “*Acanthothecis farinosa*”, which has an uncarbonized excipulum, trans-septate and small ascospores, a clear hymenium and norstictic acid but this species is distinguished from *A. kalbii* by the larger ascospores, $20\text{--}25 \times 5\text{--}7 \mu\text{m}$, 6–9-locular, the smooth paraphyses-tips and the ecorticate thallus when compared with *A. kalbii*, which has ascospores $9\text{--}15 \times 4\text{--}5 \mu\text{m}$, 4–6-locular, spiny paraphyses-tips and a corticate thallus.

***Acanthothecis pruinocarpa* Dal-Forno & Eliasaro, sp. nov.**

FIG. 2

MYCOBANK 512984

Differt ab A. corcovadensis quia offert paraphyses spinosas, periphysoides breves, ascosporas minores et ascomata irregulariter disciformia.

TYPE: BRAZIL. PARANÁ: Pontal do Paraná. PONTAL DO SUL, 28.II.2008, S25°34'02.2" W48°22'01.8", M. Dal-Forno 553 (Holotype-UPCB).

ETYMOLOGY: The specific epithet is derived from the Latin *pruina* (= a powdery deposit) + *carpus* (the Latin form of the Greek *karpos* = fruit), a reference to the ascoma with white pruina.

Thallus corticolous, epiperidermal, 40–80 μm thick, continuous, with crystals; surface smooth, corticate, dull, pale grey. Ascoma irregularly disciform, with powdery white pruina, erumpent to prominent, 0.5–1.0 mm long, 0.4–0.5 mm wide, with lateral thalline margin; disc concealed or slightly exposed, grey white pruinose; labia striate, convergent; excipulum uncarbonized, well developed, 180–240 μm high, yellow. Hymenium clear, 110–150 μm high, 160–180 μm wide, hyaline, I–; epithecium pale brown, 5.0 μm high; hypothecium indistinct; paraphyses unbranched, filiform, 1.0 μm thick, with spiny tips, hyaline; periphysoids unbranched, spiny, 10–20 μm long, 1.0–2.0 μm thick, hyaline; asci ellipsoid, $90\text{--}95 \times 20\text{--}25 \mu\text{m}$; ascospores 2 per ascus, hyaline, I–, ellipsoid, muriform, $(11\text{--})13\text{--}16 \times 2\text{--}4$ -locular, 40–70 μm long, $(7\text{--})9\text{--}14 \mu\text{m}$ wide, with thin cell walls.

CHEMISTRY: thallus K⁺ yellow, stictic acid and other stictic acid satellites present.

ADDITIONAL SPECIMENS EXAMINED – BRAZIL. PARANÁ: Pontal do Paraná. PONTAL DO SUL, 28.II.2008, S25°34'11.1" W48°21'32.4" M. Dal-Forno 349 (UPCB).

COMMENTS – *Acanthothecis pruinocarpa* is characterized by the irregularly disciform ascomata, spiny paraphyses-tips and periphysoids, an uncarbonized excipulum, hyaline, muriform ascospores, I–, 2 per ascus, $40\text{--}70 \times (7\text{--})9\text{--}14 \mu\text{m}$, and the presence of stictic acid.

Only three species of *Acanthothecis* with muriform ascospores and stictic acid as the major chemical compound are known, namely *Acanthothecis corcovadensis* (Redinger) Staiger & Kalb, *A. dialeuca* (Kremp.) Staiger & Kalb and *A. gyridia* (Stirt.) A.W. Archer.

Acanthothecis corcovadensis differs from *A. pruinocarpa* in having periphysoids that can reach more than 40 µm in length and ascospores longer than 90 µm and lirelliform ascomata (Staiger & Kalb 1999) whereas *A. dialeuca* and *A. gyridia* have smaller ascospores, up to 30 µm long, and lirelliform apothecia (Staiger 2002, Archer 2006), when compared with *A. pruinocarpa*.

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Literature cited

- Archer AW. 2006. The Lichen Family *Graphidaceae* in Australia. *Bibliotheca Lichenologica* 94: 1–191.
- Archer AW. 2007. Key and checklist for the lichen family *Graphidaceae* (lichenised *Ascomycota*) in the Solomon Islands. *Systematics and Biodiversity* 5(1): 9–22.
- Archer AW, Elix JA. 2007. Two new species in the Australian *Graphidaceae* (lichenized *Ascomycotina*). *Australasian Lichenology* 61: 18–19.
- Archer AW, Elix JA. 2008. Three new species in the Australian *Graphidaceae* (lichenized *Ascomycotina*). *Australasian Lichenology* 63: 26–29.
- Culberson CE, Ammann K. 1979. Standardmethode zur Dünnschichtchromatographie von Flechtensubstanzen. *Herzogia* 5: 1–24.
- Elix JA, Ernst-Russell KD. 1993. A Catalogue of Standardized Thin Layer Chromatographic Data and Biosynthetic Relationships for Lichen Substances. 2nd ed. Australian National University Canberra.
- Lücking R, Rivas-Plata E. 2008. Clave y Guía Ilustrada Para Géneros de *Graphidaceae*. *Glalia* 1: 1–41.
- Makhija U, Adawarkar B. 2003. A new species of *Acanthothecis* from India. *Mycotaxon* 88: 139–141.
- Makhija U, Adawarkar B. 2007. Trans-septate species of *Acanthothecis* and *Fissurina* from India. *The Lichenologist* 39(2): 165–185.
- Staiger B, Kalb K. 1999. *Acanthothecis* and other graphidioid lichens with warty periphysoids and paraphyses-tips. *Mycotaxon* 73: 69–134.
- Staiger B. 2002. Die Flechtenfamilie *Graphidaceae*: Studien in Richtung einer natürlicheren Gliederung. *Bibliotheca Lichenologica* 85: 1–526.

Four new species of *Punctelia* from São Paulo State, Brazil

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Abstract — The following new species of *Punctelia* are described from remnant cerrado forests in São Paulo State, Brazil: *Punctelia crispa*, *P. digitata*, *P. imbricata*, and *P. roseola*. A key to the seven species of *Punctelia* found in the study area is presented.

Keywords — *Punctelia colombiana*, *Punctelia constantimontium*, *Punctelia fimbriata*, *Punctelia graminicola*, *Punctelia rudecta*, *Punctelia appalachensis*

Introduction

The Brazilian cerrado is included in the savanna world biome. It is recognized as one of the world's five hot spots of biodiversity and threatened vegetation (Fonseca et al. 1999). Cerrado formation is structurally and physiognomically heterogeneous, varying from grasslands (campo limpo) to arboreal structures (cerradão) (Coutinho 1978).

In São Paulo State, cerrado vegetation originally occupied 20% of the territory, but at present only ca. 1% of the original area remains (Zorzetto et al. 2003). In an ongoing effort to describe and document the biodiversity of the lichenized mycota, a survey of *Parmeliaceae* in remnant cerrados in inland São Paulo State was performed (Jungbluth 2006). Several new species were recognized, as expected in such a diverse biome (Jungbluth et al. 2008).

Thirty species of *Punctelia* are known worldwide (Egan & Aptroot 2004), sixteen of which are recorded for Brazil (Marcelli 2004). In addition, two further Brazilian species were described recently (Canêz & Marcelli 2007).

This present paper describes four new *Punctelia* species from areas of cerrado in São Paulo State and provides an identification key for the seven species found in this vegetation type.

Material and methods

The specimens were collected in cerrado remnants in central-east São Paulo State. All the cerrado physiognomies present in the area were investigated. For more information and a map with the localities, see Jungbluth et al. (2008).

In this paper, PHYLLIDIA are considered to be dorsiventral, secondary projections that differ anatomically from the thallus, chiefly by lacking a lower cortex; LACINULES are narrow, secondary structures (reproductive or vegetative) having the same anatomic organization as the thallus that are longer than wide and distinguished from LOBULES, which are wider than long and possess rounded apices. We consider any structure SOREDIOID if it is composed of heaped soredia.

The chemistry of the thallus was determined through color reactions (spot tests) and thin layer chromatography (TLC) in solvent C, using methodology adapted from Bungartz (2001) and following the recommendations and data from Walker & James (1980), Huneck & Yoshimura (1996) and Orange et al. (2001). High performance liquid chromatography (HPLC) was performed on holotype specimens (Elix et al. 2003).

The diagnoses refer exclusively to the holotypes while the English technical descriptions refer to all the studied material.

Results and discussion

Although individual thalli may be locally common, in general species of *Punctelia* are not easily found inside cerrado forests where they are apparently somewhat limited to well lit but not directly illuminated microhabitats.

The vegetative reproductive structures found in *Punctelia* species most frequently originate from the margins of the pseudocyphellae. True soredia, isidia, and lobules are very rare in *Punctelia*, and the origin and development of vegetative propagules differs significantly from those commonly found in most of the other parmelioid genera. Therefore, it is necessary to be careful in applying indiscriminately the above terms and it must be understood that they are used by analogy because more appropriate terms are not available.

Seven taxa were found in the region investigated: *P. cf. graminicola* (B. de Lesd.) Egan, *P. punctilla* (Hale) Krog, *P. reddenda* (Stirt.) Krog, and four species new to science, described below as *P. crispa*, *P. digitata*, *P. imbricata*, and *P. roseola*.

Key to *Punctelia* species found in the São Paulo State cerradoes

- 1a. Lower surface dark brown to black at least in the center 2
- 1b. Lower surface white to pale brown throughout 4
- 2a. Lobules present *P. imbricata*
- 2b. Lobules absent 3
- 3a. Soredia absent, isidia present, medulla C+ rose, KC+ rose *P. roseola*
- 3b. Soredia present, isidia absent, medulla C–, KC– *P. reddenda*
- 4a. Margin crispate, ornamented with lobules/phyllidia *P. crispa*
- 4b. Margin entire, lobules absent 5
- 5a. Isidia present, lacinules absent *P. punctilla*
- 5a. Isidia absent, lacinules present 6
- 6a. Lacinules palmately branched *P. digitata*
- 6b. Lacinules irregularly branched *P. cf. graminicola*

The new species

Punctelia crispa Marcelli, Jungbluth & Elix, sp. nov.

FIG. 1

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DIAGNOSIS: *Affinis* *Punctelia fimbriata* sed *marginē thalli et pseudocyphellis, structuris soredioidis non corticatis instructis differt.*

HOLOTYPE—Brazil, São Paulo State, Campo Limpo Paulista Municipality, Botujuru quarter, 23°14'S 46°46'W, 750 m alt., orchard in a small farm located in a mesophyllous forest – cerrado forest transition, on tree trunk, leg. M.P. Marcelli & A.E. Luchi 17601, 20-IV-1980 (SP, isotype in F).

THALLUS grayish, corticolous, lobate, loosely adnate, to 10 cm wide. LOBES irregularly branched, contiguous, 1.5–4.0 mm wide at the base, 2.0–4.0 mm maximum width; apices rounded; margin crenate, ascending, undulate and crispate at least in the proximal areas; upper surface continuous, smooth; MACULAE faint, punctiform to sublinear, submarginal, soon forming pseudocyphellae; PSEUDOCYPHELLAE orbicular, rarely ellipsoid, with elevated borders when old; near the margin 0.15–0.60 mm wide, elsewhere up to 1.30 mm wide. PUSTULES, LACINULES, LOBULES and ISIDIA absent. PHYLLIDIA erect, soredioid (disintegrating into piles of soredia when young or after ramifying), small, 0.1–0.6(–0.8) × 0.1–0.2 mm, irregular in shape, occasionally with an eroded surface, irregularly branched, developing from the margins of lobes and pseudocyphellae. SOREDIA coarse, originating from disintegrating phyllidia and forming rounded structures ca. 0.2(–0.3) mm diam. on the pseudocyphellae or having the shape of ramified phyllidia whose density gives the proximal parts of the thallus a crispate appearance. MEDULLA white. LOWER SURFACE mostly naked, dull, pale brown in the distal parts but dark brown in the proximal parts; rugose and veined; MARGINAL ZONE erhizinate but sometimes papillate,

1.5–4.0 mm wide; RHIZINES pale brown or concolorous with the lower surface, simple to sometimes sparingly branched, 0.2–1.5 mm long, mostly grouped in the central portion of the lobes. APOTHECIA and PYCNIDIA not seen.

COLOR REACTIONS: upper cortex K+ yellow, UV–; medulla K–, C+ rose, KC+ rose, P–, UV–.

TLC/HPLC: atranorin (minor), gyrophoric acid (major), lecanoric acid (trace).

COMMENTS– *Punctelia crispa* has characteristic, ascending, undulate and crispate lobe margins (hence the specific epithet), ornamented by phyllidia, and producing soredia and soredioid structures analogous to those found in some species of *Cladonia*. The borders of the pseudocyphellae and the margins of the lobes, particularly the proximal ones, disintegrate at some points and erode, assuming a very uneven appearance and forming heaped soredioid structures, resembling eroded lobules or fringes, which can become erect, ramified or even flattened, but never corticate.

The true phyllidia present in *P. fimbriata* Marcelli & Canêz give this species a very similar crispate appearance. However, the lobes of *P. fimbriata* have a black lower surface with a narrow, brown margin, and the holotype (SP!) has smaller pseudocyphellae [0.05–0.12(–0.20) mm diam.] with no obvious elevated margins.

Punctelia stictica (Delise ex Duby) Krog (G, holotype!) exhibits irregularly aggregated soredia ca. 0.1 mm diam. which become granular. The lower surface is dark brown to black.

Punctelia missouriensis G. Wilh. & Ladd (IMI, isotype!) forms clustered granules which sometimes resemble isidioid structures, but it has a cracked upper surface, unornamented lobe margins and produces lecanoric acid as a major medullar component.

***Punctelia digitata* Jungbluth, Marcelli & Elix, sp. nov.**

FIG. 2

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DIAGNOSIS: *Affinis* *Punctelia* *graminicola* sed *lacinulis digitiformibus presentibus differt*.

HOLOTYPE—Brazil, São Paulo State, Itirapina Municipality, 22°15'S 47°49'W, 770 m alt., Estação Experimental do Instituto Florestal, Pedregulho, cerrado forest, on tree trunk, leg. P. Jungbluth, A.A. Spielmann & L.S. Canêz 807, 24-III-2004 (SP, isotype in ASU).

THALLUS grayish, lobate, adnate, 4.5–10.0 cm wide. LOBES irregularly branched, contiguous, 0.5–3.0 mm wide at the base, 2.0–4.0 mm maximum width, apices rounded; margin crenate to dentate or lacinulate; upper surface continuous or sometimes irregularly cracked, smooth. MACULAE faint or distinct, irregular, marginal, developing pseudocyphellae. PSEUDOCYPHELLAE laminal and marginal, mostly orbicular, plane to excavate, emarginate, 0.05–0.20 mm diam.,

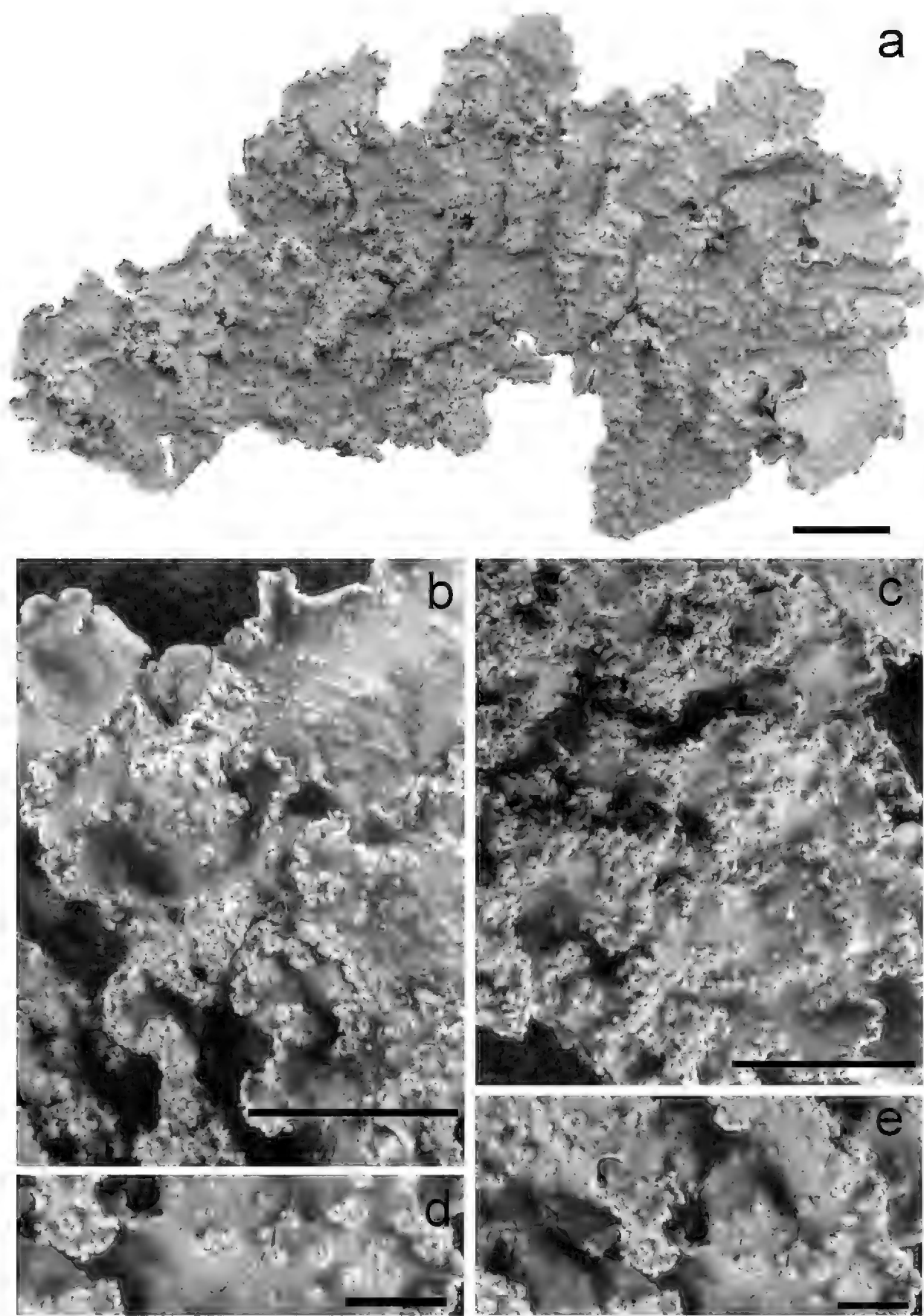


FIGURE 1. *Punctelia crispa* holotype.
a. Part of the holotype. b. Young part of the thallus and crispate margin.
c. Older part of the thallus. d, e. Soredia and crispate margin initial formation.
Bars: a,b,c = 5 mm; d,e = 2 mm.

hidden by lacinules in the proximal region. PUSTULES, LOBULES, PHYLLIDIA, SOREDIA and ISIDIA absent. LACINULES abundant on the margins of lobes and older pseudocyphellae, $0.1\text{--}0.8 \times 0.1\text{--}0.2$ mm, flat and prostrate, simple to irregularly branched or commonly palmate, apices acute to truncate, sometimes with apical pseudocyphellae. MEDULLA white. LOWER SURFACE white to very faint brown, shiny, smooth to slightly rugose; MARGINAL ZONE white to shiny olivaceous or bluish, 1.0–4.0 mm wide, with a gradual change of color from the margin to the center, smooth to veined; ERHIZINATE MARGIN 0.5–2.0 mm wide; RHIZINES concolorous with the lower surface, simple or rarely irregularly branched, 0.2–1.5 mm long, abundant, evenly distributed. APOTHECIA and PYCNIDIA not seen.

COLOR REACTIONS: upper cortex K+ yellow, UV–; medulla K–, C+ red, KC+ red, P–, UV–.

TLC/HPLC: atranorin (trace), lecanoric acid (major).

PARATYPE—Brazil, São Paulo State, Itirapina Municipality, 22°15'S 47°49'W, 770 m alt., Estação Experimental do Instituto Florestal, Pedregulho, cerrado forest, on tree trunk, leg. P. Jungbluth, A.A. Spielmann & L.S. Canêz 805, 24-III-2004 (SP).

COMMENTS— *Punctelia digitata* has characteristic, palmately branched reproductive lacinules that resemble prostrate, \pm imbricate, flattened isidia which originate from the margins of the lobes and pseudocyphellae. This species has a white to pale brown lower surface and lecanoric acid in the medulla. The mature pseudocyphellae are orbicular and excavate; the older ones may give rise to cracks.

Punctelia graminicola has irregularly branched, flat vegetative lacinules, which develop at the truncate apices of the main lobes (ASU, lectotype!).

Punctelia punctilla, *Punctelia rudecta* (Ach.) Krog and *Punctelia subflava* are three further species with a pale lower surface and medullary lecanoric acid.

Punctelia punctilla (LD, holotype!) differs from *P. digitata* in its isidioid phyllidia that never become soredioid [although Krog (1982) and Riefner (1989) describe the isidia as papilliform, sparsely branched, with an opaque surface and which may become almost coralloid with age].

Punctelia rudecta has clustered simple to branched cylindrical isidia (H-Ach 1337, holotype!), which are sometimes said to become squamuliform and dorsiventral (Krog 1982, Ferraro 1986), but never assume the typical digitate structures found in *P. digitata*.

Unlike *P. digitata*, *Punctelia subflava* has an upper surface that is typically subscrobiculate near the margins and develops marginal lobules and sparsely ramified phyllidia less than 0.6 mm long (FH, holotype!) that are often mainly lobate-squamuliform and spread over the lamina of the older lobes (Elix & Johnston 1988, Elix 1994).

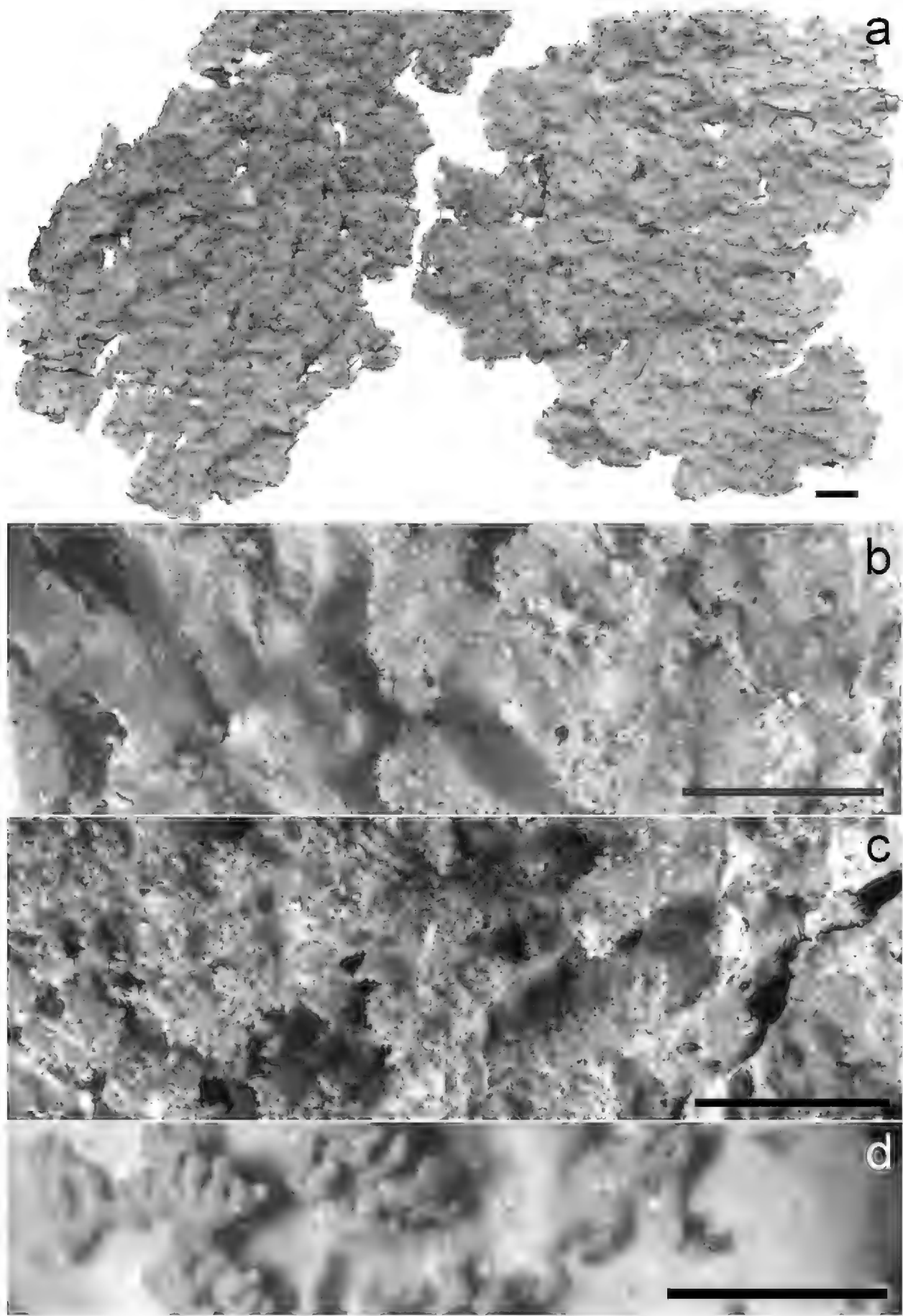


FIGURE 2. *Punctelia digitata* holotype.
a. Part of the holotype. b. Young part of the thallus.
c. Older part of the thallus. d. Detail of the palmate lacinules.
Bars: a,b,c = 5 mm; d = 1 mm.

Punctelia appalachensis (W.L. Culb.) Krog (DUKE, holotype!; H, isotype!), which produces protolichesterinic acid in medulla (C–), has a very similar general habit and palmate propagules but with a black lower surface and the lacinules that are erect and commonly longer than 1 mm, in contrast to the prostrate lacinules up to 0.8 mm long in *P. digitata*.

The specific epithet refers to the shape of the lacinules present in this species.

***Punctelia imbricata* Marcelli, Jungbluth & Elix, sp. nov.**

FIG. 3

MB 512458

DIAGNOSIS: *Affinis* *Punctelia constantimontium* sed *lobis majoribus et lobulis subtus non erosio differt*.

HOLOTYPE—Brazil, São Paulo State, Campo Limpo, Paulista Municipality, Figueira Branca, 23°12'S, 46°47'W, 750 m alt., orchard inside a small farm, on trunk of *Mangifera indica* in a shaded and humid place, leg. P. Jungbluth 1079, 13-V-2004 (SP, isotypes in B and S).

THALLUS greenish grey, lobate, adnate, 15–20 cm wide. LOBES irregularly branched, contiguous to overlapping laterally, 2.0–4.0 mm wide at the base, 4.5–8.0(–10.0) mm maximum width, apices rounded; margin crenate to crenulate or irregularly incised; upper surface continuous, smooth, becoming slightly rugose with age; MACULAE absent; PSEUDOCYPHELLAE punctiform, laminal and marginal, flat to slightly elevated, not excavate, 0.1–0.3 mm diam. PUSTULES, LACINULES, PHYLLIDIA, SOREDIA and ISIDIA absent. LOBULES abundant, mostly roundish, usually convex but some flat or concave, 0.3–1.5 × 0.2–1.0(–3.0) mm, ascending to ±procumbent and imbricate, simple to irregularly branched, rarely incised, growing from the upper surface (not from the pseudocyphellae) and proliferating to produce more lobules, with marginal pseudocyphellae, some developing rhizines. MEDULLA white. LOWER SURFACE black, dull, smooth to rugose and veined; MARGINAL ZONE faint brown, shiny, 1.5–3.5 mm wide, well delimited from the center, papillate, without rhizines, 1.5–3.0 mm wide; RHIZINES whitish and cream, blackened in just a few areas at the center of the thallus, simple, 0.1–0.5 mm long, frequent, grouped. APOTHECIA not seen. PYCNIDIA mainly on the lobules; CONIDIA unciform, 4–6 × ca. 1 µm.

COLOR REACTIONS: upper cortex K+ yellow, UV–; medulla K–, C+ rose, KC+ rose, P–, UV–.

TLC/HPLC: atranorin (trace), gyrophoric acid (major), orcynyl lecanorate (minor), lecanoric acid (trace).

COMMENTS—*Punctelia imbricata* is characterized by the ascending to imbricate, laminal lobules that do not originate from pseudocyphellae, the black lower

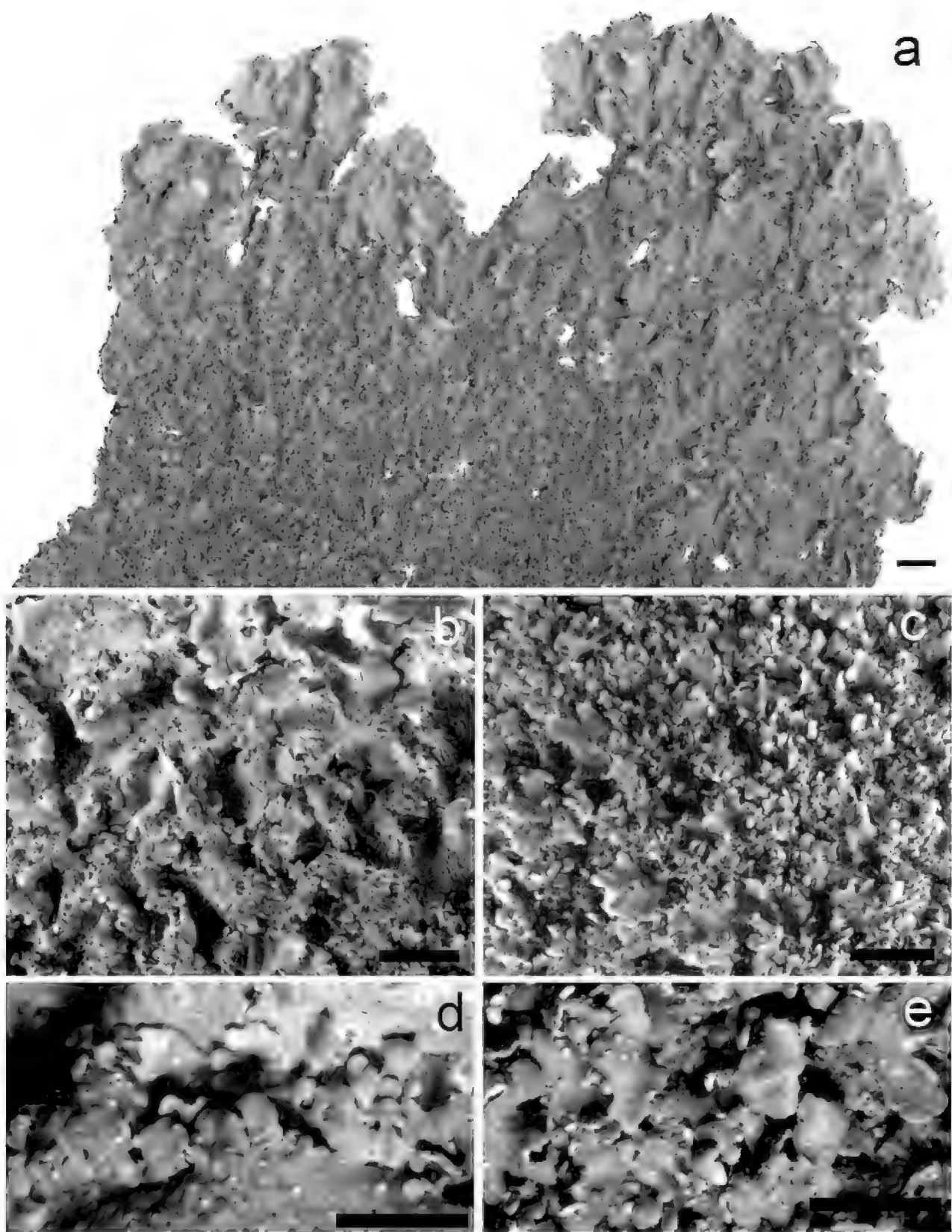


FIGURE 3. *Punctelia imbricata* holotype.
a. Part of the holotype. b. Young part of the thallus.
c. Older part of the thallus. d, e. Detail of the lobules.
Bars: a,b,c = 5 mm; d,e = 2 mm.

surface, 4–6 μm long unciform conidia, and the presence of gyrophoric acid as the major medullary substance. The pseudocyphellae are punctiform or rarely elliptical, plane at first but then somewhat elevated.

Punctelia constantimontium Sérus. differs in having narrower lobes (less than 3 mm wide) and lobules up to 0.1–0.4(–0.8) mm long and with eroded lower cortex. The lower surface of the lobules in *P. imbricata* is corticate, and some develop rhizines. Furthermore, the pseudocyphellae of *P. constantimontium* are smaller [0.05–0.1(–0.3) mm in diameter] and laminal, and only rarely develop on the lacinules (BM, holotype! and L.S. Canêz pers. comm.)

Despite the similar original description (Sérusiaux 1984), *P. colombiana* Sérus. has isidia which are associated with the pseudocyphellae and become flattened, and this species produces filiform conidia (S, holotype! and L.S. Canêz pers. comm.).

***Punctelia roseola* Jungbluth, Marcelli & Elix, sp. nov.**

FIG. 4

MB 512459

DIAGNOSIS: Affinis Punctelia colombiana sed margine integra, isidiis cylindricis instructis et substantias butlerinas continente differt.

HOLOTYPE—Brazil, São Paulo State, Jurumirim Municipality, 23°11'37"S 49°17'46"W, 535 m alt., about 300 m from Tietê River margin, a large isolated tree in a pasture on a small farm, in a dry, clear place without direct sunlight, corticolous, leg. M.P. Marcelli, J. Vieira Filho & F.A.S. Berchez 17578, 20-VI-1979 (SP, isotype in BM).

THALLUS gray but becoming tan in the herbarium, lobate, adnate, 10–20 cm wide. **LOBES** irregularly or rarely dichotomously branched, contiguous to overlapping laterally, 2.5–6.0 mm wide at the base, 4.0–9.0 mm maximum width, apices rounded; margin crenate, undulate; upper surface continuous, smooth to slightly notched in the center of the thallus; **MACULAE** absent; **PSEUDOCYPHELLAE** orbicular, laminal, convex, 0.05–0.15 mm wide. **PUSTULES**, **LACINULES**, **PHYLLIDIA**, **LOBULES** and **SOREDIA** absent. **ISIDIA** concolorous with the upper surface, originating as granules along the margins of the pseudocyphellae, soon expanding to form cylindrical, slightly moniliform and irregularly branched structures, which become somewhat flattened and dorsiventral with age, 0.2–0.5 mm long, erect, laminal, mainly in the center of the thallus. **MEDULLA** white to very faint rose. **LOWER SURFACE** pale to dark brown (almost black) in the center, dull, rugose and papillate; **MARGINAL ZONE** brown, 1.0–3.0 mm wide, dull, smooth to papillate and veined, the erhizinate portion 1.5–2.5 mm wide, shiny; **RHIZINES** cream, darkening in the center of the thallus, simple, 0.2–0.6 mm long, frequent to abundant, evenly distributed. **APOTHECIA** immature, concave, 1.0–3.0 mm wide, sessile, laminal, margin smooth, amphithecium pseudocyphellate, disc dark brown, imperforate; **ASCOSPORES** not seen. **PYCNIDIA** submarginal; **CONIDIA** filiform, (6–)8–11 \times ca. 1 μm .

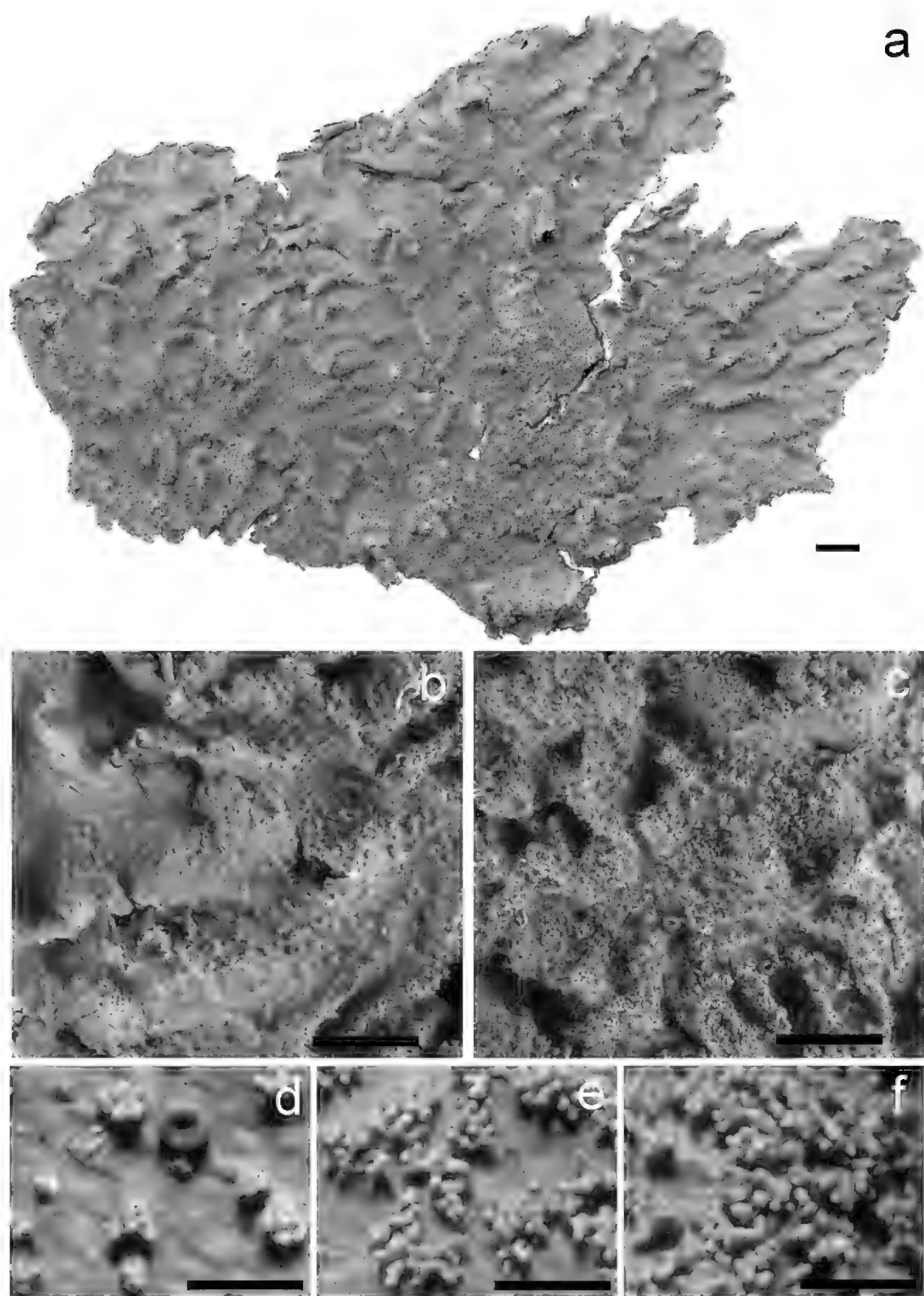


FIGURE 4. *Punctelia roseola* holotype.
a. Part of the holotype. b. Young part of the thallus.
c. Older part of the thallus. d, e, f. Stages of isidia development.
Bars: a,b,c = 5 mm; d,e,f = 1 mm.

COLOR REACTIONS: upper cortex K+ yellow, UV–; medulla K+ faint rose, C+ rose, KC+ rose, P–, UV–.

TLC/HPLC: atranorin (minor), gyrophoric acid (major), butlerin D (submajor), lecanoric acid (minor), butlerin A, butlerin B, butlerin E, butlerin F (all minor).

PARATYPES—Brazil, São Paulo State, same locality and habitat as the type, leg. M.P. Marcelli, J. Vieira Filho & F.A.S. Berchez 17574 (SP), 17575 (B, H), 17576 (SP), 17577 (SP), 17580 (NY), 20-VI-1979.

COMMENTS — *Punctelia roseola* is characterized by its unique pale rose medulla (can be mistaken by white without a good white illumination) associated to irregularly branched “isidia”, a pale- to dark brown lower surface, filiform conidia 6–11 µm long, medullary gyrophoric acid and butlerins.

The pseudocyphellae are orbicular, laminal, convex, and very soon obscured by isidia.

This species is very similar to *P. colombiana* in the distribution and shape of the cylindrical isidia that become flat and dorsiventral; however, those of *P. colombiana* have eroded lower cortices. Furthermore, *P. colombiana* has a black lower surface with a narrow, dark brown marginal zone (S, holotype!), while *P. roseola* has a dull brown lower surface which ranges from very pale brown at the margin to dark in the center, without a distinct marginal zone.

Punctelia stictica (G, holotype!) has a dark lower surface, medullary gyrophoric acid and similar conidia to those of *P. roseola*; however, *P. stictica* produces granular soredia that sometimes develop into pseudoisidia.

Punctelia constantimontium (BM, holotype!) and *P. imbricata* also have a black lower surface and medullary gyrophoric acid, but both produce lobules and have unciform conidia.

The epithet refers to the color of the medulla and the two larger TLC spots (butlerins).

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Literature cited

- Bungartz F. 2001. Analysis of lichen substances. In http://nhc.asu.edu/lichens/lichen_info/tlc.jsp#TLC2. Accessed on July 2008.
- Canêz LS, Marcelli MP. 2007. Two new species of *Punctelia* (*Parmeliaceae*) from southern Brazil. *Mycotaxon* 99: 211–216.
- Coutinho LM. 1978. O conceito de cerrado. *Revista Brasileira de Botânica* 1: 17–23.
- Egan RS, Aptroot A. 2004. *Punctelia*. In: Nash III TH, Ryan BD, Diederich P, Gries C, Bungartz F (eds.). *Lichen Flora of the Greater Sonoran Desert Region. Volume 2. Lichens Unlimited*, Arizona State University, Tempe, Arizona, USA. pp. 431–436.
- Elix JA. 1994. *Punctelia*. *Flora of Australia* 55: 163–168.
- Elix JA, Johnston J. 1988. New species in the lichen family *Parmeliaceae* (*Ascomycotina*) from the southern hemisphere. *Mycotaxon* 31: 491–510.
- Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. *Bibliotheca Lichenologica* 86: 1–7.
- Ferraro LI. 1986. Contribution to the study of Argentine *Parmeliaceae*. The genus *Punctelia* Krog and *Flavopunctelia* (Krog) Hale. *Phytologia* 61: 189–203.
- Fonseca GAB, Mittermeier RA, Cavalcanti R, Mittermeier CG. 1999. Brazilian Cerrado. In Mittermeier RA, Myers N, Mittermeier CG (eds.). *Hotspots Earth's Biologically Richest and most Endangered Terrestrial Ecoregions*. CEMEX, Conservation International. 431 p.
- Huneck S, Yoshimura I. 1996. *Identification of lichen substances*. Springer. Berlin. 493 p.
- Jungbluth P. 2006. A família *Parmeliaceae* (fungos liquenizados) em fragmentos de cerrados do Estado de São Paulo. Mastership dissertation, Instituto de Botânica, São Paulo, 323 p.
- Jungbluth P, Marcelli MP, Elix JA. 2008. Five new species of *Bulbothrix* (*Parmeliaceae*) from cerrado vegetation in São Paulo State, Brazil. *Mycotaxon* 104: 51–63.
- Krog H. 1982. *Punctelia*, a new lichen genus in the *Parmeliaceae*. *Nordic Journal of Botany* 2: 287–292.
- Marcelli MP. 2004. Checklist of lichens and lichenicolous fungi of Brazil. In http://www.biologie.uni-hamburg.de/checklists/brazil_1.htm. Accessed on December 2004.
- Orange A, James PW, White FJ. 2001. *Microchemical Methods for the Identification of Lichens*. British Lichen Society. 101p.
- Riefner RE Jr. 1989. *Punctelia punctilla* (Hale) Krog, new to North America. *Phytologia* 67(3): 254–257.
- Sérusiaux E. 1984. *Punctelia colombiana* sp. nov. (*Parmeliaceae*). *Nordic Journal of Botany* 4(5): 717–718.
- Walker FJ, James PW. 1980. A revised guide to microchemical techniques for the identifications of lichen products. *Bulletin of the British Lichen Society* 46(suppl.): 13–29.
- Zorzetto R, Fioravanti C, Ferroni M. 2003. A floresta renasce. *Revista Pesquisa Fapesp* 91: 48–53.

A new species of *Selenosporella* and two microfungi recorded from a cloud forest in Mérida, Venezuela

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Abstract — *Selenosporella setosa*, a new anamorphic fungus collected on decaying leaves of an unidentified plant, is described and illustrated. *S. setosa* is characterized by subulate conidiophores with 1–4 verticillate, sessile setae near the apex and lunate, hyaline, one-celled conidia. *S. perramosa* comb. nov. is proposed to accommodate *Selenodriella perramosa*. A key to treated *Selenosporella* species and illustrations are provided. Two other species of anamorphic fungi are recorded and illustrated from Venezuela.

Key words — systematics, conidial fungi

Introduction

Over 35 anamorphic fungi were collected during a mycological survey of microfungi from tropical plant material in several undisturbed cloud forests in Venezuela near “Las Chorreras vía Jají, La Carbonera and San Eusebio, Estado Mérida” between 2000–2485 m alt. Among the collections was a conspicuous fungus clearly related to the genus *Selenosporella* G. Arnaud ex MacGarvie, which appears to be new to science.

Materials and methods

Samples of plant material were placed in separate paper bags and taken to the laboratory. Material was air dried for 12 h. and damp chambers were prepared in the laboratory and incubated for 4–10 days at 30° C. Leaf litter decoction agar was prepared by boiling 60g of decaying leaves in 1 L of distilled water for 30 min. The extract was supplemented with 1.3% of agar, pH adjusted to 6.0, and the agar was autoclaved for 20 min. Fungi were isolated into pure culture by transferring single conidia observed under a stereo microscope onto Petri dishes of leaf decoction agar and incubated at 25° C with 12 h alternating cycles of daylight/dark.

Mounts were prepared in polyvinyl alcohol-glycerol (8 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of $\times 1000$. Micrographs were obtained with a Zeiss Axioskop 40 microscope and a Jeol JSM-6400 scanning electron microscope using the techniques described previously by Figueras & Guarro (1988).

Taxonomy

Selenosporella setosa R.F. Castañeda & B. Guerrero, **anam. sp. nov.**

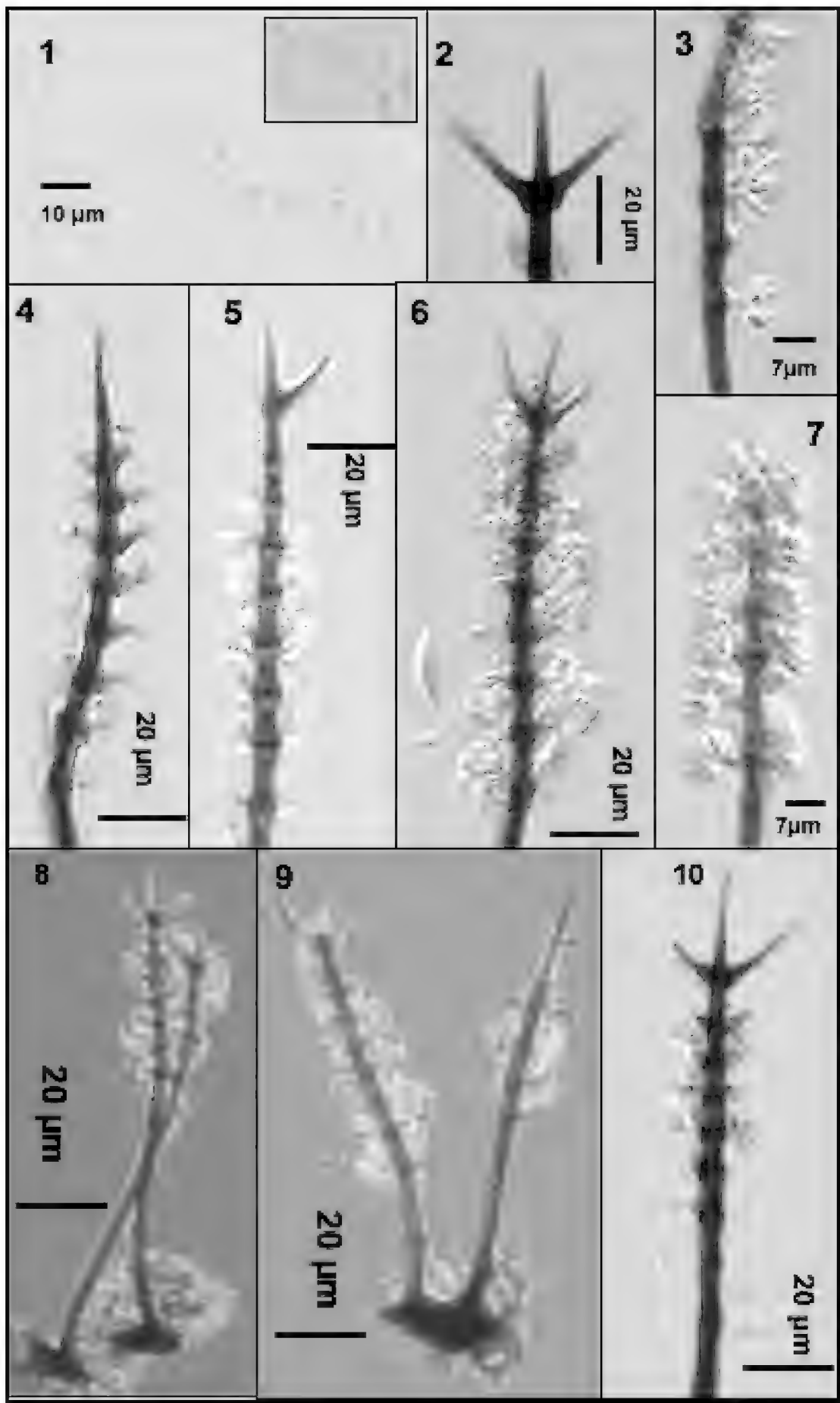
MYCOBANK, MB 512684

FIGS. 1–10, 23–24

COLONIAE in substrato naturali effusae, pilosae, amphigenae, brunneae vel nigrae. *MYCELIUM* plerumque superficiale et aliquot in substrato immersum. *Hyphae* septatae, ramosae, laeves, brunneae, 1.0–2.5 μm diam. *SETAE* cylindricae, ampliata ad basim, obtusae ad apicem, 0–2 septatae, 21.6–32.4 \times 6.2–7.2 μm , atrobunneae versus pallidiora ad apicem; interdum in conidiophoris mutatis. *CONIDIOPHORA* macronemata, mononemata, erecta, plerumque ramosa et setosa ad apicem, laevia, 120–265 \times 12.5–20 μm , atrobunnea. *CELLULAE CONIDIOGENAE* polyblasticae, lageniformes vel subulatae, sympodiales, indeterminatae, 8–10 \times 6–9(–17) μm , subhyalinae, cum denticulis inconspicuis, 1–4 in verticilli, supra vel infra septum insertae, plerumque in septum dispositae. *CONIDIA* solitaria, lunata, utrimque acerosa, unicellularia, hyaline vel subhyalina, 4.5–5.5 \times 1.2–1.8 μm , laevia, sicca.

TYPE: VENEZUELA. MÉRIDA: ANDEAN CLOUDY FOREST, SAN EUSEBIO, VÍA MERIDA A LA AZULITA, 2435 M HIGH, on rotten leaves of an unidentified plant, 24.VII.2008, B. Guerrero and G. M. Adamo (**HOLOTYPE:** HAL 2298 F, 2299 F slides).

ETYMOLOGY: Latin, *setosa*, referring to the setae borne near the apex of conidiophores.



FIGS. 1–10. *Selenosporella setosa*, photomicrographs from holotype (HAL 2298 F). FIG. 1. Conidia. FIG. 2. Apical setae. FIGS. 3–10. Setose conidiophores, conidiogenous cells and conidia. Scale is indicated by bars.

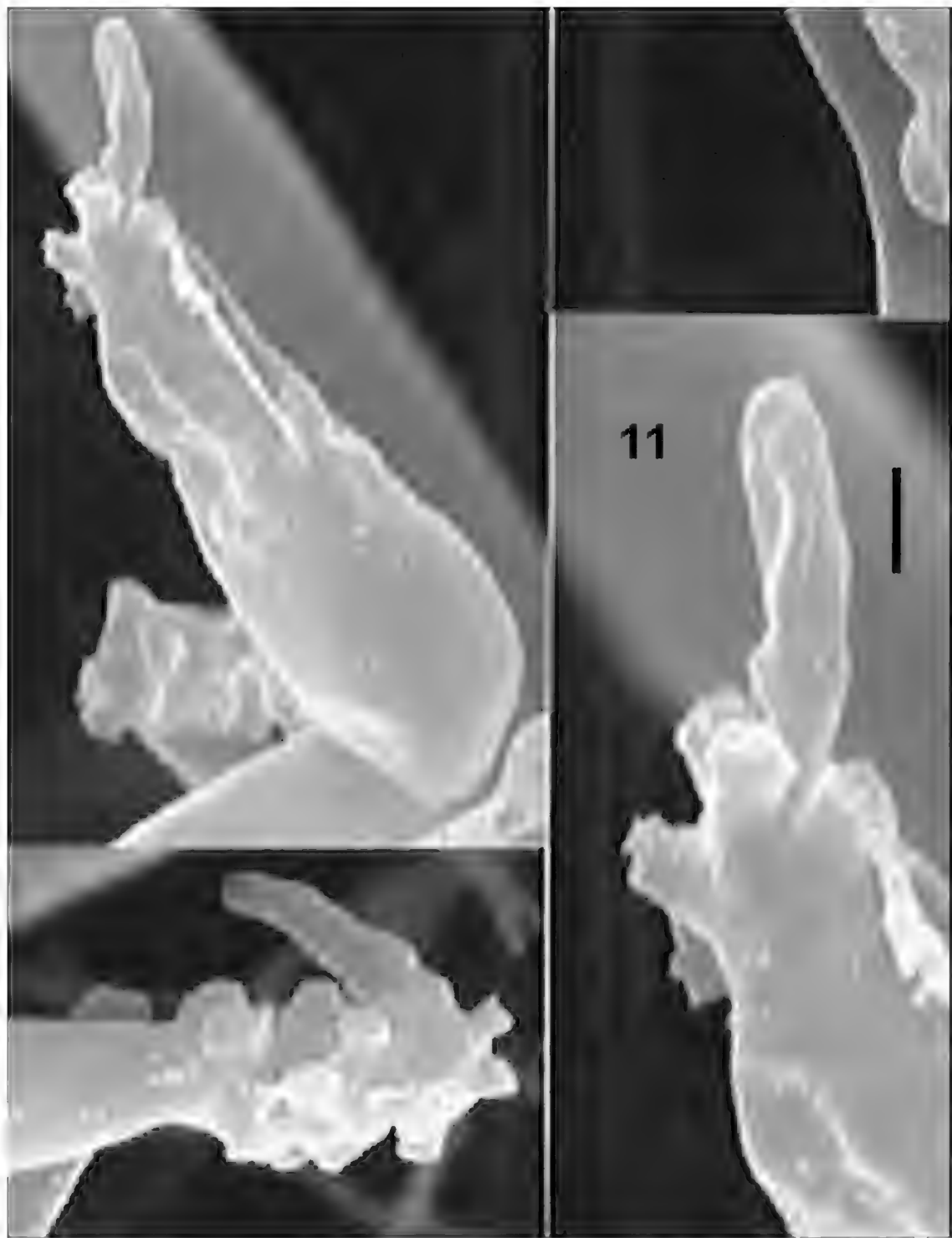


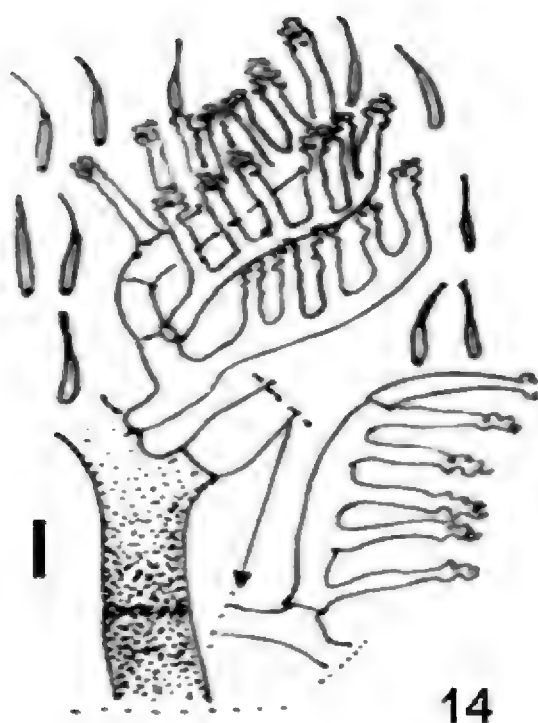
FIG.11. *Selenosporella curvispora*, photomicrographs (SEM) from culture (CBS 102623). Conidiogenous cells, denticulate loci and conidia. Bar = 1 μ m.

COLONIES on the natural substrate effuse, hairy, amphigenous, brown or black. MYCELIUM mostly superficial and somewhat immersed. Hyphae septate, branched, smooth-walled, brown, 1.0–2.5 μ m. SETAE cylindrical, broad at the base, obtuse towards the apex, 0–2-septate, 21.6–33.4 \times 6.2–7.2 μ m, dark brown versus pale brown towards the apex; sometimes developing into secondary conidiophores with apical cell producing several conidia. CONIDIOPHORES

12



13



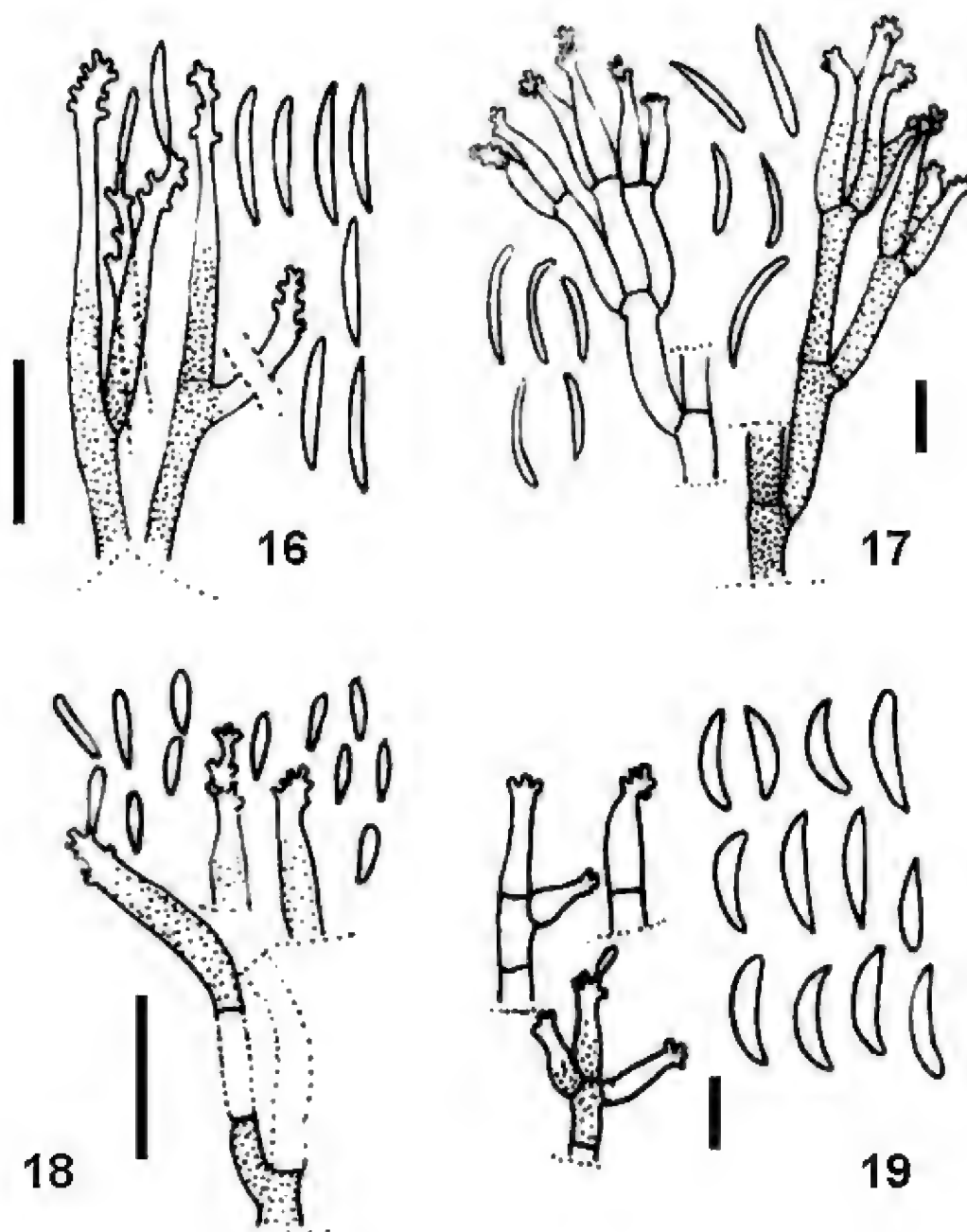
14



15

FIGS. 12–15. Conidiogenous cells and conidia of *Selenosporella* species, redrawn from the original descriptions. FIG. 12. *S. acicularis*. FIG. 13. *S. aristata*. FIG. 14. *S. conglutinata*. FIG. 15. *S. curvispora*. Bars = 10 μ m.

macronematous, mononematous, erect, mostly branched and setose at apex, smooth, $120\text{--}265 \times 12.5\text{--}20 \mu\text{m}$, dark brown. CONIDIOGENOUS CELLS polyblastic, lageniform or subulate, sympodially proliferating, indeterminate,



FIGS. 16–19. Conidiogenous cells and conidia of *Selenosporella* species, redrawn from the original descriptions. FIG. 16. *S. falcata*. FIG. 17. *S. gliocladioides*. FIG. 18. *S. cymbiformis*. FIG. 19. *S. nandiensis*. Bars = 10 µm.

with inconspicuous denticles, 1–4 verticils arranged perpendicular to the axis, inserted below or above septum. CONIDIA solitary, acrogenous, lunate, acerose at the ends, unicellular, hyaline or subhyaline, $4.5\text{--}5.5 \times 1.2\text{--}1.8$ µm, smooth-walled, dry.

NOTES: ten species are recognized in the genus *Selenosporella*: *S. acicularis* B. Sutton & Hodges (FIG. 12), *S. aristata* Kuthub. & Nawawi (FIG. 13), *S. conglutinata* R.F. Castañeda (FIG. 14), *S. curvispora* G. Arnaud ex MacGarvie (FIGS. 11,15), *S. cymbiformis* B. Sutton (FIG. 18), *S. falcata* B. Sutton (FIG. 16),

S. gliocladioides Helfer (FIG. 17), *S. nandiensis* B. Sutton (FIG. 19), *S. queenslandica* Matsush. (FIG. 20) and *S. verticillata* B. Sutton & Hodges (FIG. 21). *S. setosa* is close to *S. nandiensis* and *S. verticillata* in the shape of the conidia. *S. nandiensis* has conidia $10\text{--}16 \times 2.5\text{--}3.5 \mu\text{m}$ and has two types of conidiophores, one bearing a single terminal conidiogenous cell, and the other with 0–4 lateral or slightly verticillated conidiogenous cells. *S. verticillata* has conidiogenous cells that are not perpendicular, larger conidia ($6.0\text{--}9.0 \mu\text{m}$) relative to *S. setosa*, and the conidia are abruptly tapered to an acute apex, but gradually tapered to an obtuse base. Setae are not present in *S. nandiensis* and *S. verticillata*.

Selenosporella anamorphs and synanamorphs for ascomycetes *Oxydothis selenosporellae* and *Iodosphaeria* have been reported by Samuel & Rossman (1987) and Samuels et al. (1987) respectively, but have also been connected with *Eutypa spinosa* (Glawe & Rogers 1986) whose anamorph strongly resembles *S. gliocladioides*. Several genera of anamorphic fungi—*Acrodictys*, *Arachnophora*, *Diplococcium*, *Endophragmiella*, *Ceratosporium*, *Chaetendophragmia*, *Laterispora*, *Phialocorona*, *Porosubramaniana*, *Quadracaea*, *Sporidesmium*, and *Teratosperma*—have been reported with *Selenosporella*-like synanamorphs by Wang & Sutton (1998). *Sopagraha*, considered synonymous with *Arachnophora* (Kirk et al 2008) has also been reported to have a *Selenosporella* synanamorph, and other reports are for: *Endophragmiella variabilis* (Castañeda 1988); *Echinosphaeria canescens*, *Ruzenia spermoides* and *Lasiosphaeria punctata* (Miller & Huhndorf, 2004); *Spadicoides obclavata* and *S. obclavata* var. *heterocolorata* (Castañeda et al 1997); *Polytretophora calcarata* and *P. dendroidea* (Kuthubutheen & Nawawi 1991); and *Iyengarina asymmetrica* and *I. furcata* (Kuthubutheen & Nawawi 1992). All the *Selenosporella* synanamorphs are associated with taxa characterized by blastic development, and are not reported to occur in genera with thallic/arthric development. Holoblastic conidium ontogeny and denticulate conidiogenous in *Selenosporella curvispora* was confirmed using scanning electron microscopy by Onofri & Castagnola (1982).

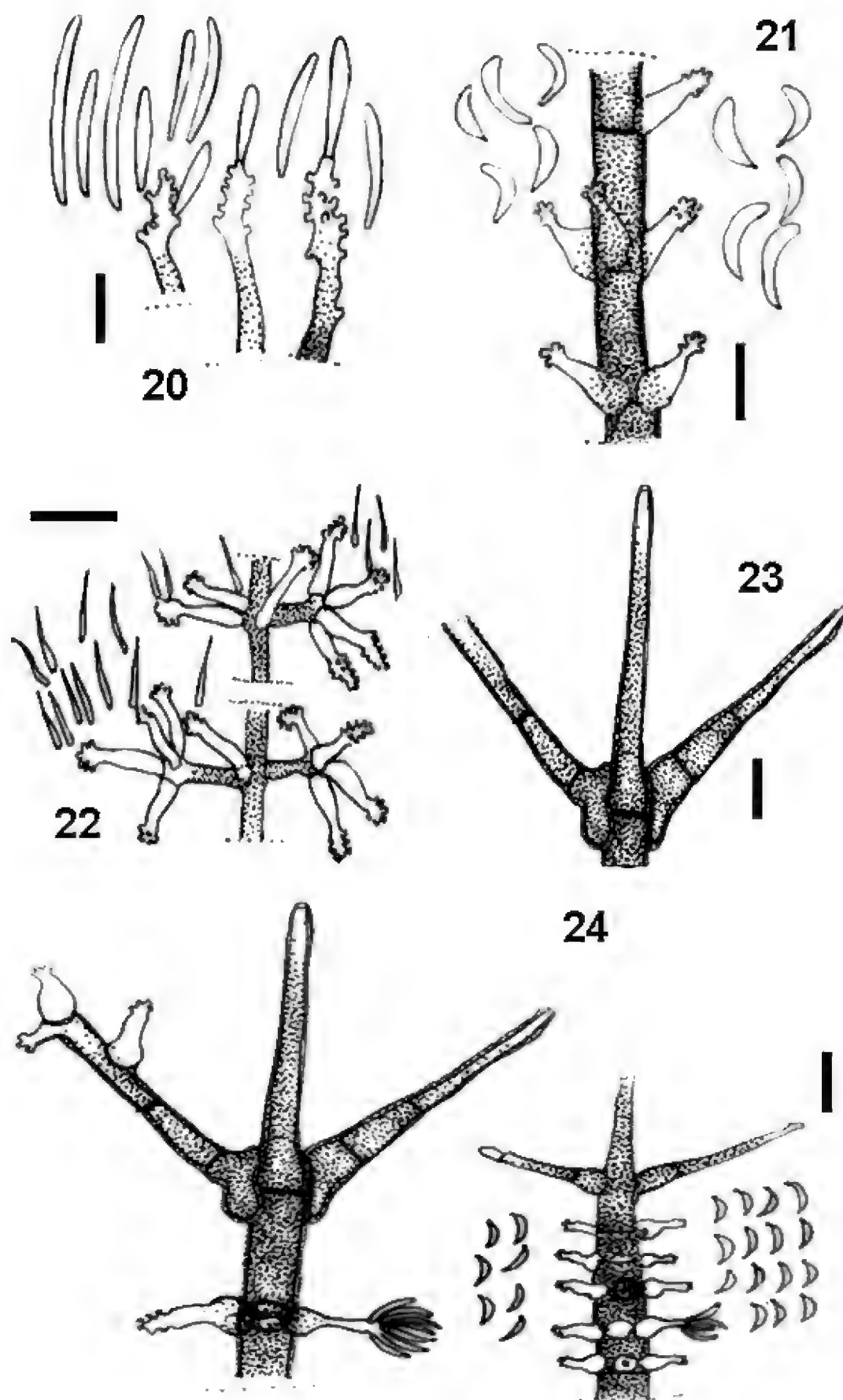
Conidiogenous cells and branches in *Selenodriella perramosa* are disposed in verticils and inserted in the main axis and in long branches of the conidiophores as in described species of *Selenosporella*. In *Selenodriella*, conidiogenous cells are mostly sessile on the conidiophores, therefore *Selenodriella perramosa* is better accommodated in *Selenosporella*, and a new combination is proposed.

***Selenosporella perramosa* (W.B. Kendr. & R.F. Castañeda) R.F. Castañeda, comb. nov.**

FIG. 22

MYCOBANK MB 513262

BASIONYM: *Selenodriella perramosa* W.B. Kendr. & R.F. Castañeda,
University of Waterloo Biology Series 33: 36 (1990).



FIGS. 20–24. Conidiogenous cells and conidia of *Selenosporella* species, redrawn from the original descriptions. FIG. 20. *S. queenslandica*. FIG. 21. *S. verticillata*. FIG. 22. *S. perramosa*. FIGS. 23–24. *S. setosa*. Bars = 10 μm.

Key to *Selenosporella* species

- 1a. Conidiogenous cells discrete, arranged in verticils2
- 1b. Conidiogenous cells integrated, not arranged in verticils7
- 1c. Conidiogenous cells integrated and discrete, not arranged in verticils and slightly verticillate, two type of conidiophores usually present, the shorter one $45\text{--}92 \times 3.5\text{--}4.5 \mu\text{m}$, 2–6-septate with 0–4 conidiogenous cells slightly verticillate near the apex, the longer $160\text{--}200 \times 5\text{--}6 \mu\text{m}$, up to 11-septate with conidiogenous cell integrated, conidia fusiform, sub-lunate or falcate, rounded at the apex, tapered towards the bases, $10\text{--}16 \times 2.5\text{--}3.0 \mu\text{m}$, unicellular, hyaline *S. nandiensis*
- 2a. Conidiogenous cells mostly subpenicillate, conidia cylindrical to falcate, slightly curved at the apex, $9\text{--}16 \times 1.0\text{--}1.5 \mu\text{m}$, unicellular, hyaline *S. gliocladioides* and *Selenosporella* anamorph of *Eutypa spinosa*
- 2b. Conidiogenous cells not subpenicillate3
- 3a. Conidia acicular or aristate4
- 3b. Conidia not acicular or aristate5
- 4a. Conidiogenous cells slightly verticillate at the conidiophore apex, conidia acicular, $9.5\text{--}14.5 \times 1 \mu\text{m}$, unicellular, hyaline *S. acicularis*
- 4b. Conidiogenous cells verticillate many times along the conidiophore and branches, conidia acicular, $5\text{--}10 \times 0.5\text{--}1.0 \mu\text{m}$, unicellular, hyaline . *S. perramosa*
- 4c. Conidiogenous cells verticillate many times along the conidiophore, conidia aristate, setulose towards the apex, $18\text{--}25 \times 1 \mu\text{m}$, unicellular, hyaline *S. aristata*
- 5a. Setae cylindrical, broad at the base, obtuse towards the apex, 0–2-septate, $21.6\text{--}33.4 \times 6.2\text{--}7.2$, brown at the base, pale brown towards the apex, arising near the apex of the conidiophores, conidia lunate, acerose at the ends, unicellular, $4.5\text{--}5.5 \times 1.2\text{--}1.8 \mu\text{m}$, unicellular, hyaline or subhyaline *S. setosa*
- 5b. Setae or setose element arising from the conidiophores6
- 6a. Conidia lunate, acute at the apex and obtuse at the base, $6\text{--}9 \times 1.5 \mu\text{m}$, unicellular, hyaline *S. verticillata*
- 6b. Conidia narrowly cylindrical-botuliform, curved, $5\text{--}8 \times 1.0\text{--}1.5 \mu\text{m}$, unicellular, hyaline *S. curvispora*
- 7a. Conidia cymbiform, $3.5\text{--}4.5 \times 1 \mu\text{m}$, unicellular, hyaline *S. cymbiformis*
- 7b. Conidia falcate, $8.5\text{--}11.0 \times 1.5 \mu\text{m}$, unicellular, hyaline *S. falcata*
- 7c. Conidia cylindrical-botuliform, curved, truncated at the base, rounded at the apex, $7.5\text{--}16 \times 1.0\text{--}1.5 \mu\text{m}$, unicellular, hyaline *S. queenslandica*
- 7d. Conidia acicular, straight or curved, broad and truncated at the base, $8\text{--}18 \times 0.5\text{--}1.0 \mu\text{m}$, unicellular, hyaline *S. conglutinata*

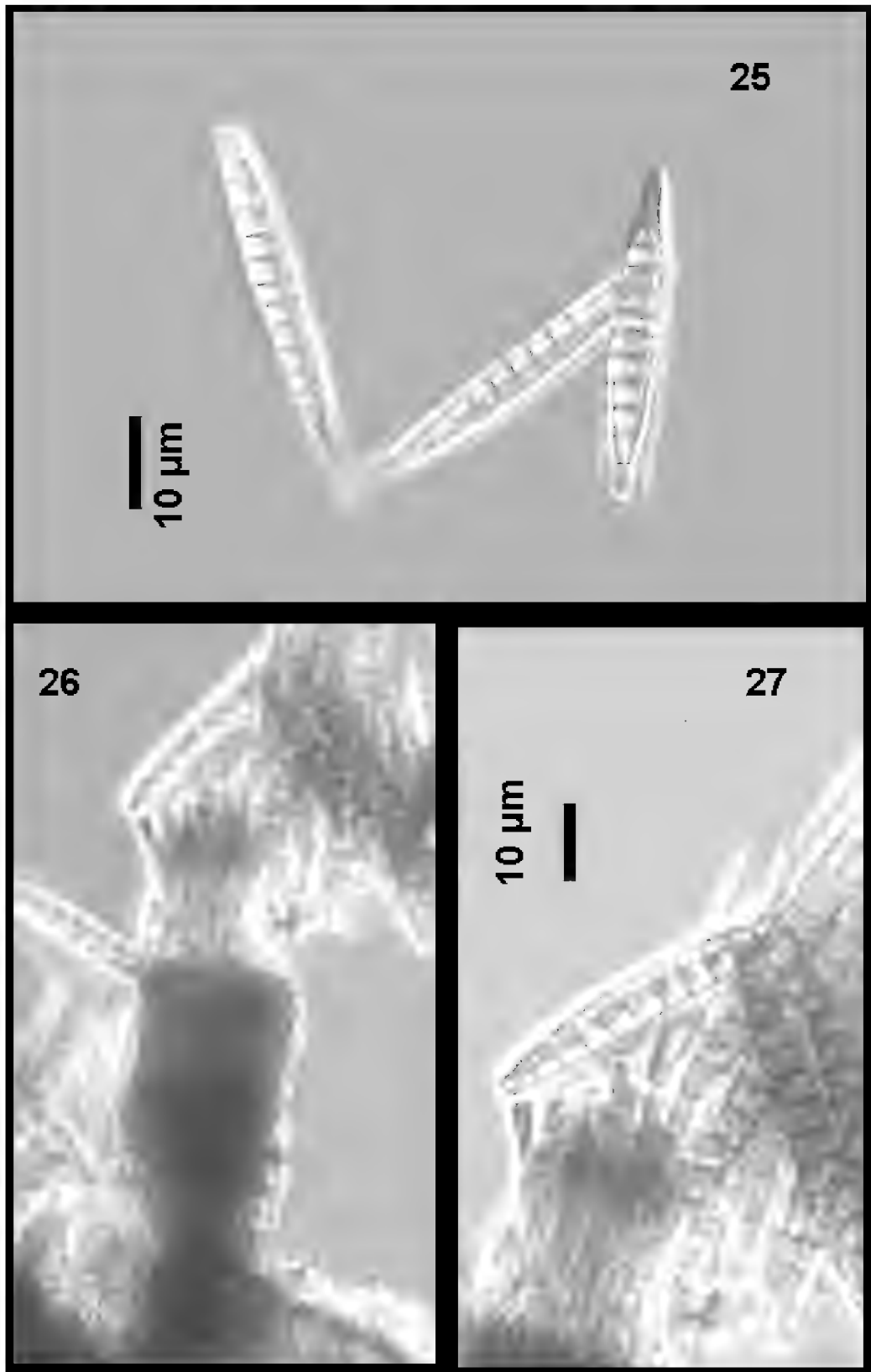
Other anamorphic fungi recorded from Venezuela, Mérida.

Bactrodesmium longisporum M.B. Ellis, 1976, More Dematiaceous

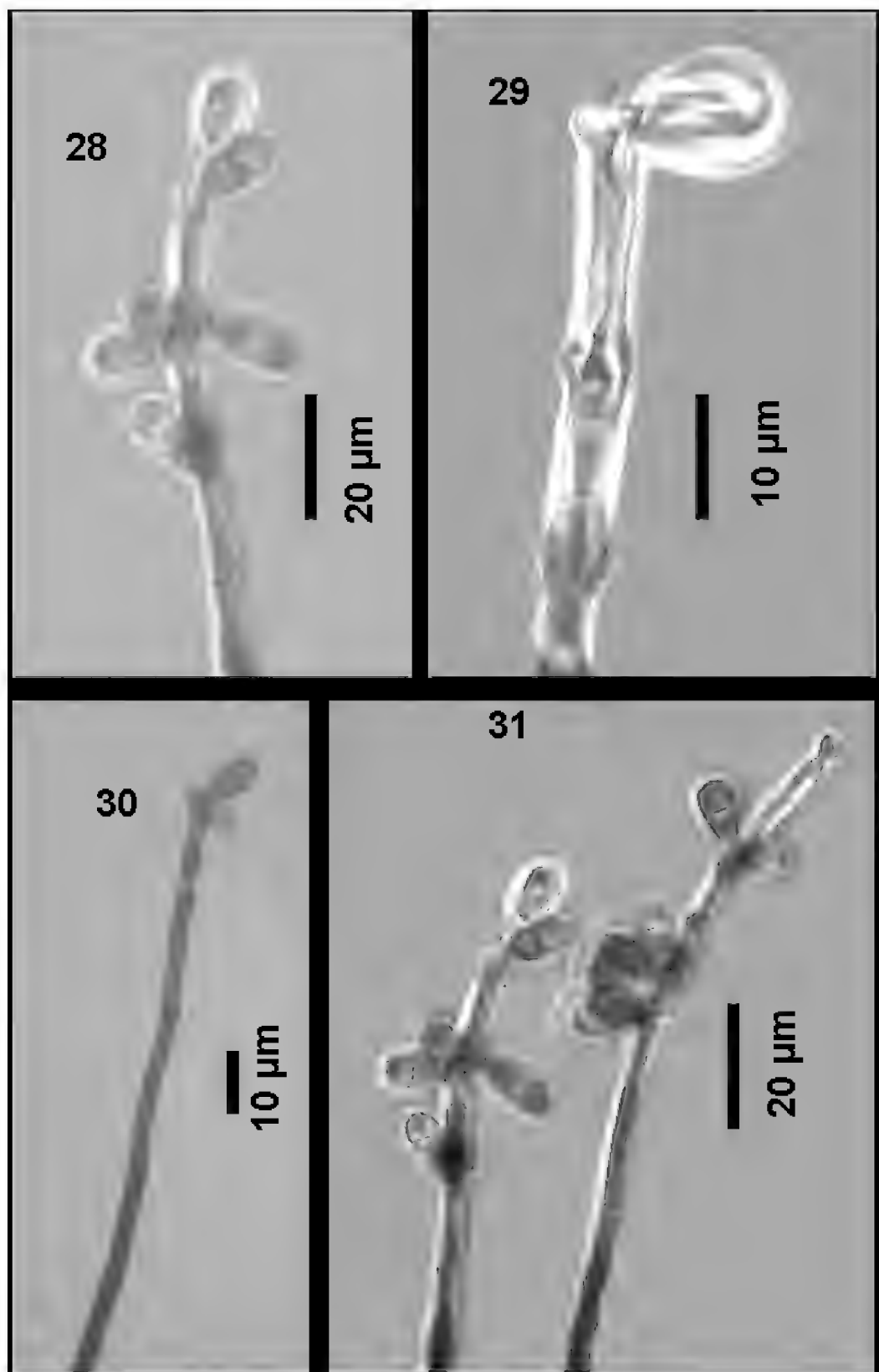
Hyphomycetes, CMI., Kew, p. 68.

FIGS. 25–27

SPECIMEN EXAMINED: VENEZUELA. MÉRIDA: ANDEAN CLOUD FOREST, SAN EUSEBIO, VÍA MERIDA A LA AZULITA, on twig, 24.VII.2008, B. Guerrero and G. M. Adamo (INIFAT C08/15-1).



FIGS. 25–27. *Bactrodesmium longisporum*, photomicrographs from (INIFAT C08/15–1). FIG. 25. Conidia. FIGS. 26–27. Synnema, conidiogenous cells and conidia. Scale is indicated by bars.



FIGS. 28–31. *Cordana abramovii*, photomicrographs from (INIFAT C08/15). Conidiophores, conidiogenous cells and conidia. Scale is indicated by bars.

Cordana abramovii Seman & Davydkina, 1983, Nov.Syst. Pl. non vasc.
20: 115.

FIGS. 28–31

SPECIMEN EXAMINED: VENEZUELA. MÉRIDA: ANDEAN CLOUD FOREST, SAN EUSEBIO, VÍA MERIDA A LA AZULITA, on twig, 24.VII.2008, B. Guerrero and G. M. Adamo (INIFAT C08/15).

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Literature cited

- Castañeda Ruiz RF. 1988. Fungi Cubenses III. Instituto de Investigaciones Fundamentales en Agricultura Tropical “Alejandro de Humboldt” Havana, Cuba , 27 pp. 36 figs.
- Castañeda Ruiz RF, Guarro J, Cano J. 1997. Notes on conidial fungi XII. New or interesting hyphomycetes from Cuba. *Mycotaxon* 63: 169–181.
- Figueras MJ, Guarro J. 1988. A scanning electron microscopic study of ascoma development in *Chaetomium malaysiense*. *Mycologia* 80: 298–306.
- Glawe DA, Rogers JD. 1986. Conidial states of some species of *Diatrypaceae* and *Xylariaceae* . *Can. J. Bot.* 64: 1493–1498.
- Helfer W. 1991. Pilze auf Pilzfruchtkörpern. Untersuchungen zur Ökologie, Systematik und Chemie. *Libri Botanici* 1: 157 pp. Eching: IHW-Verlag. 1991.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the Fungi 10th Edition, CAB International, Oxon, UK.
- Kuthubutheen AJ, Nawawi A. 1991. Two new species of *Spadicoides* from Malaysia. *Mycol. Res.* 95: 163–168.
- Kuthubutheen AJ, Nawawi A. 1991. *Polytretophora dendroidea* sp. nov. and *P. calcarata* (Hyphomycetes) from Malaysia. *Mycol. Res.* 95: 623–627.
- Kuthubutheen AJ, Nawawi A. 1992. New litter-inhabiting hyphomycetes from Malaysia. *Isthmophragmospora verruculosa*, *Iyengarina asymmetrica*, and *Iyengarina furcata*. *Can. J. Bot.* 70: 101–106..
- Miller AN, Huhndorf SM. 2004. A natural classification of *Lasiosphaeria* based on nuclear LSU rDNA sequences. *Mycol. Res.* 108: 26–34.
- Onofri S, Castagnola M. 1982. Scanning electron microscopy on some dematiaceous sympodially proliferating hyphomycetes. *Mycotaxon* 14: 125–139.
- Samuels GJ, Rossman AY. 1987. Studies in the *Amphisphaeriaceae* (*sensu lato*): 2. *Leiosphaerella cocoes*, new combination and two new species of *Oxydothis* on palms. *Mycotaxon* 28: 461–472.
- Samuels GJ, Müller E, Petrini O. 1987. Studies on the *Amphisphaeriaceae* (*sensu lato*): 3. New species of *Monographella* and *Pestalospaeria* and two new genera. *Mycotaxon* 28: 473–499.
- Wang CJK, Sutton BC. 1998. *Diplococcium hughesii* sp. nov. with *Selenosporella* synanamorph. *Can. J. Bot.* 76:1608–1613.

**Studies on the genus *Paecilomyces* in China.
Application of DELTA expert system on the entomopathogenic
*Paecilomyces sensu lato***

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Abstract — The DELTA expert system was used for the first time to study the genus *Paecilomyces*. A DELTA database of twenty-four entomopathogenic *Paecilomyces* in China was established and successfully used to create a key, natural language taxon descriptions, a phenetic tree, and an interactive identification system. These results will provide an effective platform for the exchange of information with both domestic and foreign workers.

Key words — entomopathogenic fungi, numerical classification

Introduction

The classical methods of taxon identification and subsequent preparation of keys and characteristic descriptions involve time-consuming and laborious procedures. At the same time, the order and content of descriptions are often inconsistent, with some items even omitted, which can make identifications unreliable. To meet this problem, several expert software systems are emerging. One of the most representative is the DELTA (DEscription Language for TAXonomy) expert system software (Chen & Kuoh 2000a, b; Chen 2003, 2004). It has been selected as the standard for the biological taxonomy data by the international taxonomic database working group (Dallwitz 2000a, b).

The purpose of this study is to establish the DELTA database of entomopathogenic *Paecilomyces sensu lato* in China and explore its functional extensions.

* Corresponding author

Materials and methods

Materials

A *Paecilomyces* DELTA database was constructed for the species listed in TABLE 1 using information mainly from the Institute of Fungal Resources, Guizhou University, along with other world reports.

TABLE 1. Entomopathogenic *Paecilomyces* spp. used for constructing the DELTA database.

NAME	REFERENCE
<i>Paecilomyces amoeneroseus</i> (Henn.) Samson	Samson 1974, Liu & Liang 2003
<i>P. atrovirens</i> Z.Q. Liang & A.Y. Liu	Liang et al. 2003
<i>P. breviramosus</i> Bissett	Tzean et al. 1997
<i>P. cateniannulatus</i> Z.Q. Liang	Liang 1981
<i>P. cateniobliquus</i> Z.Q. Liang	Liang 1981
<i>P. cicadae</i> (Miq.) Samson	Samson 1974, Liang et al. 2003, Chen 1991
<i>P. farinosus</i> (Holmsk.) A.H.S. Br. & G. Sm.	Samson 1974, Tzean et al. 1997, Liang 1981, Brown & Smith 1957, Li et al., 2003
<i>P. fumosoroseus</i> (Wize) A.H.S. Br. & G. Sm.	Samson 1974, Tzean et al. 1997, Brown & Smith 1957, Li et al. 2003
<i>P. fumosoroseus</i> var. <i>beijingensis</i> Q.X. Fang & Q.T. Chen	Fang et al. 1983
<i>P. griseoviridis</i> M.X. Dai	Dai 1998
<i>P. gunnii</i> Z.Q. Liang	Liang 1985
<i>P. gunnii</i> var. <i>minor</i> Z.Z. Li et al.	Li et al. 1999
<i>P. javanicus</i> (Friedr. & Bally) A.H.S. Br. & G. Sm.	Samson 1974, Brown & Smith 1957
<i>P. lilacinus</i> (Thom) Samson	Samson 1974, Li et al. 2003.
<i>P. loushanensis</i> Z.Q. Liang & A.Y. Liu	Liang et al. 1997
<i>P. marquandii</i> (Masse) S. Hughes	Samson 1974, Brown & Smith 1957
<i>P. militaris</i> Z.Q. Liang	Liang 2001
<i>P. nostocoides</i> M.T. Dunn	Michael 1983
<i>P. odonatae</i> Zuo Y. Liu et al.	Liu et al. 1995–96
<i>P. rariramus</i> Z.Q. Liang & B. Wang	Liang et al. 2002
<i>P. sinensis</i> Q.T. Chen et al.	Chen et al. 1984
<i>P. suffultus</i> (Petch) Samson	Samson 1974
<i>P. tenuipes</i> (Peck) Samson	Samson 1974, Tzean et al. 1997
<i>P. xylariiformis</i> (Lloyd) Samson	Samson 1974

Methods

The DELTA system was presented with data from the selected *Paecilomyces* strains, and its functions were used to prepare a key, natural language taxon descriptions, a phenetic tree, and an interactive identification system (Chen et al. 2003; Aiken et al. 1996; Dallwitz et al. 1995a, b; Dallwitz 1974, 1980; Heywood 1979).

Results

Establishment of DELTA database for tested *Paecilomyces sensu lato*

Twenty important characters of *Paecilomyces* were coded according to the requirements of the DELTA system. The characters and character states are listed below in TABLE 2.

TABLE 2. Characters and character states in *Paecilomyces*.

#1. Synnemata/ 1. present/ 2. absent/ #2. Colony < colour1>/ 1. light/ 2. coloured/ #3. Colony <color 2>/ 1. green/ 2. purple/ 3. pink/ 4. red/ #4. Reverse <colour1>/ 1. light/ 2. brown/ 3. red/ 4. green/ #5. Conidiophore <smooth or rough>/ 1. smooth/ 2. rough/ #6. <Conidiophore1>/ 1. complex/ 2. not complex/ #7. <conidiophore 2>/ 1. absent/ 2. simple/ #8. Phialides at the basal portion <Shape1>/ 1. cylindrical/ 2. ellipsoidal/ 3. subglobose/ 4. lecythiform/ #9. <Mode1>/ 1. solitary/ 2. not solitary	#10. Phialides Length/um long/ #11. Phialides Width/um wide/ #12. Conidia <Surface>/ 1. smooth/ 2. rough/ #13. Conidia <type>/ 1. with one type/ 2. with two different types / #14. Conidia <Shape1>/ 1. subglobose/ 2. ellipsoidal/ 3. fusiform/ 4. reniform/ 5. triangular/ 6. cylindrical/ 7. clavate/ #15. Conidia Length/um long/ #16. Conidia Width/um wide/ #17. Conidial chain <Arrangement>/ 1. straight / 2. imbrate/ 3. straight or in head/ #18. Chlamydospore <Present or Absent>/ 1. present/ 2. absent/ #19. Host<1>/ 1. general insect / 2. special animal / #20. Host<2>/ 1. Nematode/ 2. Odonata
--	--

Key to Chinese entomopathogenic *Paecilomyces*

1	Colony light	2
	Colony dark	16
2	Phialides at the basal portion cylindrical	3
	Phialides at the basal portion not cylindrical	8
3	Conidial chain straight	4
	Conidial chain not straight	6
4	Reverse light; Synnemata present; Conidia smooth; not ellipsoidal ..	<i>P. javanicus</i>
	Reverse dark; Synnemata absent; Conidia rough; ellipsoidal	5
5	Chlamydospore present	<i>P. gunnii</i>
	Chlamydospore absent	<i>P. gunnii</i> var. <i>minor</i>
6	Conidia subglobose; straight or in head	<i>P. militaris</i>
	Conidia not subglobose; imbricate	7
7	Conidia ellipsoidal	<i>P. cateniobliquus</i>
	Conidia not ellipsoidal	<i>P. loushanensis</i>
8	Conidia ellipsoidal	9
	Conidia not ellipsoidal	14
9	Conidial chain straight	10
	Conidial chain not straight	13
10	Conidiophore complex	11
	Conidiophore not complex	12
11	Reverse light	<i>P. farinosus</i>
	Reverse dark	<i>P. sinensis</i>
12	Conidia ellipsoidal	<i>P. xylariiformis</i>
	Conidia not ellipsoidal	<i>P. suffultus</i>
13	Conidia chain imbricate; Conidia with one type; Host: not <i>Odonata</i>	<i>P. cateniannulatus</i>
	Conidia chain straight or in head; Conidia with two different types; Host: <i>Odonata</i>	<i>P. odonatae</i>
14	Conidia subglobose; not complex	<i>P. rariramus</i>
	Conidia not subglobose; complex	15
15	Conidia ellipsoidal	<i>P. breviramusus</i>
	Conidia not ellipsoidal	<i>P. tenuipes</i>
	Conidia not ellipsoidal	<i>P. cicadae</i>
16	Reverse light	17
	Reverse dark	20
17	Colony purple; Nematode	18
	Colony not purple; general insect	<i>P. fumosoroseus</i>
	Colony not purple; general insect	<i>P. fumosoroseus</i> var. <i>beijingensis</i>

- | | | |
|----|--|--|
| 18 | Conidia with one type; Conidia not subglobose 19 | |
| | Conidia with two different type; Conidia subglobose <i>P. nostocoides</i> | |
| 19 | Conidiophore smooth; Chlamydospore present <i>P. marquandii</i> | |
| | Conidiophore rough; Chlamydospore absent <i>P. lilacinus</i> | |
| 20 | Cylindric at the basal portion of Phialides <i>P. griseoviridis</i> | |
| | Not cylindrical at the basal portion of Phialides 21 | |
| 21 | Synnemata present; complex; Conidia subglobose; conidial chain straight
..... <i>P. amoeneroseus</i> | |
| | Synnemata absent; not complex; Conidia not subglobose; conidial chain not
straight <i>P. atrovirens</i> | |

This key was fast and simple to use. From the key contents, these entomopathogenic *Paecilomyces* were primarily differentiated by colony color, shape of phialides at the base, shape and aggregation form of conidia, and host specificity.

Natural language descriptions

Some examples are as follows:

P. catenobliquus Z.Q. Liang

Synnemata present. Colony 30 mm, pink, floccose. Reverse orange. Mycelium smooth, 1–1.5 µm. Conidiophore smooth, simple, 90–150 µm long, 1–1.5 µm wide. Phialides at the basal portion cylindrical or subglobose to globose; or on the branched conidiophore, in a whorl of 2–4 phialides. Phialides 8.5–12 µm long, 1–1.5 µm wide. Neck 0.5 µm wide. Conidia smooth, hyaline, with one type, ellipsoidal or cylindrical, 2.5–12 µm long, 1–2.5 µm wide. Conidial chain imbricate. Chlamydospore absent. Mesophilic.

TELEOMORPH: *Cordyceps*.

HABIT: *Lepidoptera*.

P. militaris Z.Q. Liang

Synnemata present. Colony 50 mm, yellowish to ecru-olive or orange, floccose. Reverse yellow. Mycelium smooth. Conidiophore smooth, simple. Phialides at the basal portion cylindrical; or on the branched conidiophore, in a whorl of 3–5 phialides. Phialides 6–20 µm long, 0.5–1.5 µm wide. Neck 0.5 µm wide. Conidia smooth, hyaline, with one type, subglobose or globose, 1–3 µm long, 1.5–3 µm wide. Conidial chain straight or in head. Chlamydospore absent. Mesophilic.

TELEOMORPH: *Cordyceps*.

HABIT: Various insects of *Lepidoptera*.

P. odonatae Zuo Y. Liu, Z.Q. Liang & A.Y. Liu

Colony 55–63 mm. Colony white, floccose. Reverse yellow. Mycelium smooth. Conidiophore smooth, complex. Phialides at the basal portion ellipsoidal or awl-shaped,

solitary; or on the branched conidiophore, in a whorl of 2–4 phialides. Phialides 4.8–17 μm long, 1.8–2.4 μm wide. Conidia smooth, hyaline, with two different types, ellipsoidal or cylindrical or fusiform, 2.4–4.2 μm long, 1.7–2.2 μm wide. Conidial chain straight or in head. Chlamydospore absent. Mesophilic.

TELEOMORPH: *Cordyceps*.

HABIT: *Odonatae*.

Although some of the DELTA descriptions needed small editorial modifications, this method resulted in a great saving of time and energy for text input.

Numerical taxonomy analysis

DISTANCE MATRIX GENERATED BY DELTA SYSTEM: Distance coefficients and distance locations between 24 operation taxonomic units (OUT) were calculated and sorted using all 20 characters. The majority of the distance coefficients were greater than 0.03, and the DELTA system distance matrix distinguished their differences. It also provided the basic data for generation of a phenetic tree and other systematic analysis.

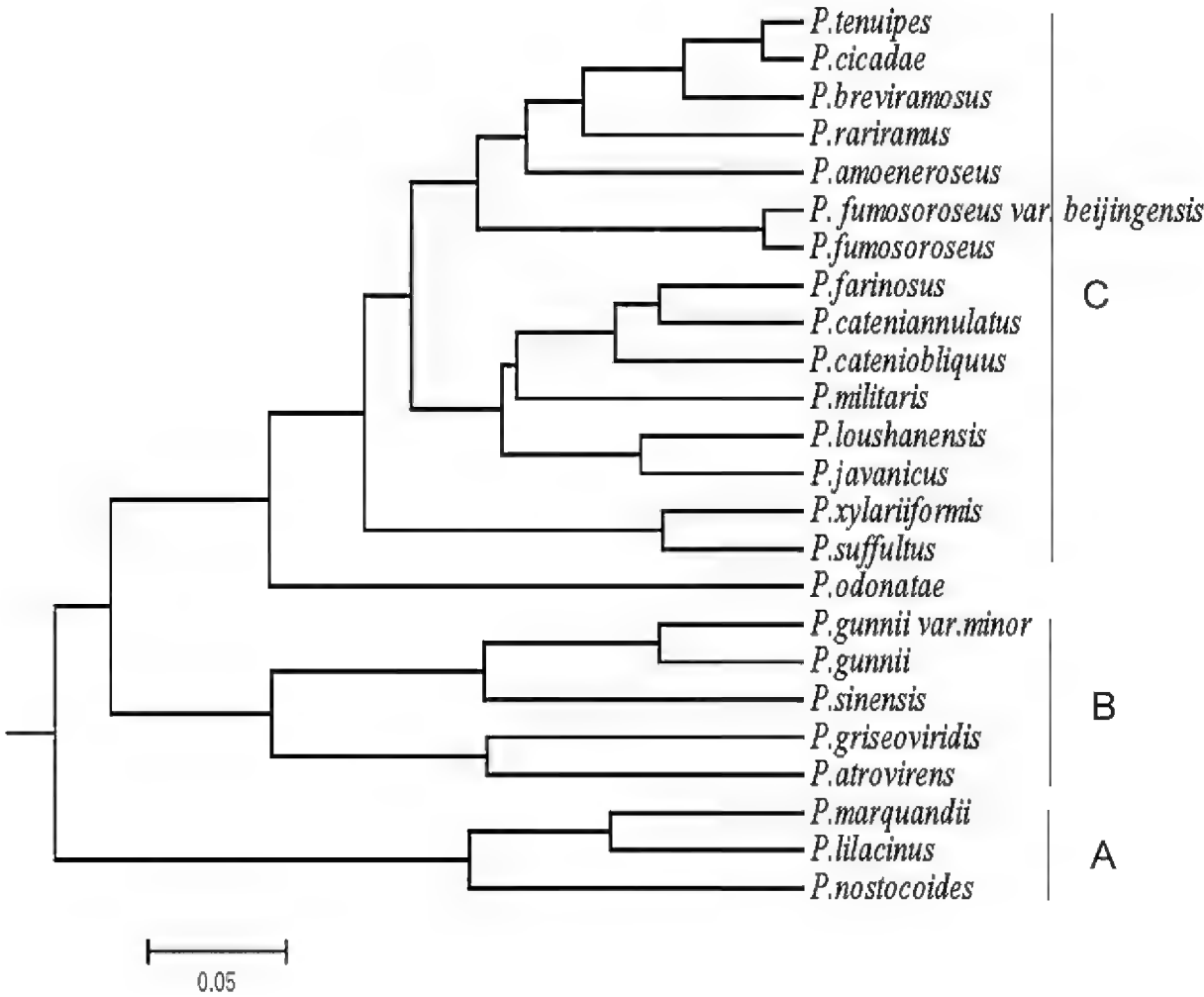


FIG. 1 Phenetic tree from Chinese twenty-four entomopathogenic *Paecilomyces* species by the DELTA system

PHENETIC TREE GENERATED BY DELTA SYSTEM: Numerical classification does not normally place priority weighting on characters. In this study all twenty chosen characters were given equal value and not weighted. The phenetic tree based on morphological characters (FIG. 1) shows species clearly divided into three groups.

Characters shared among the three group A species are purple colony color, oval-shape phialides base, straight-chain conidia, and parasitizing nematodes, indicating that host specificity (e.g., insects, nematodes) is an important character in entomopathogenic *Paecilomyces* classification.

Shared characters among the five group B taxa are a greenish colony color with a brown reverse, straight-chain conidia, and parasitizing insects. In early classification, *Paecilomyces* never explicitly appeared really green. The phenetic tree established by DELTA system supports to a certain extent that colors are significant in differentiating *Paecilomyces* species.

The fifteen group C taxa share bright colors, produce synnemata, and parasitize insects. The tree shows *P. odonatae* as a separate species very close to group C; it is characterized by two (cylindrical and oval) spore types and a dragonfly host (unique within *Paecilomyces*). The phenetic tree truly reflected the unique character.

Interactive identification system

The system provided a useful experts system platform for professional workers and other related researchers.

Discussion

Bainier established the form genus *Paecilomyces* in 1907 based on morphological and biological characters with *P. variotii* Bainier as type species. Samson (1974) recognized and described in detail 31 species which he divided into sect. *Paecilomyces* and sect. *Isarioidea*. With the development of molecular techniques, the phylogenetic analysis of *Paecilomyces* had made a great progress (Han et al. 2005, 2007; Liang et al. 2007). Luangsa-ard et al. (2004), who studied the phylogenetic relationships in *Paecilomyces* sensu lato, showed that *Paecilomyces* was polyphyletic across two subclasses, *Sordariomycetidae* and *Eurotiomycetidae*. Analysis of the phylogenetic relationships of *Paecilomyces* sect. *Isarioidea* species revealed that entomopathogenic species with *Cordyceps* teleomorphs were monophyletic and designated as members of the genus *Isaria* (Luangsa-ard et al. 2005). However, some entomopathogenic species — such as *P. lilacinus*, *P. marquandii*, *P. gunnii*, and *P. odonatae* (Luangsa-ard et al. 2005; Liang 1985; Liu et al. 1995–96) — not yet included in the genus *Isaria* need further study to determine their true relationships with one another. So *Paecilomyces* spp. in the broad sense were used in our study.

Handling documents, samples, data, and other information is very time-consuming and laborious regardless of the particular perspectives and methods adapted by individual taxonomists. After Liu (2006) suggested that computer databases and expert systems could effectively reduce conventional information processing and improve efficiency, adoption of computerized analyses were eagerly anticipated by taxonomists,

The DELTA expert system is a rapid procedural operation, and has many other advantages, such as diverse functions that enable the morphological characters to be routinely standardized digitally and thus suitable for international communication (Li 1996). These advantages allow building of databases to ensure complete and satisfactory results. The selection of the characters and states is closely related, so that only by establishing a complete and accurate database is it possible to produce high-quality function extensions. To achieve this, researchers must carefully find, analyze, and select characters. Constructing of a database requires accurate character states and uniform terminology. Any inconsistent and nonstandard terms used in descriptions will hinder the accuracy of identification. Traditional classification often employs qualitative adverbs such as “longer..., wide..., narrow...” and so on that depend on visual interpretations by different researchers and so are unlikely to be identical. Vague descriptions will hence affect identification. Uniform terms require researchers to be familiar with the classification group, and should be summarized to include as much information as possible.

A database of the Chinese entomopathogenic *Paecilomyces* was created successfully in this study. It also produced a key, natural language descriptions, an interactive identification system, and a phenetic tree. However, characters useful for diagnosis in classical identification, such as the form of conidial aggregation, are not revealed by the phenetic tree because the states are unweighted and given equal treatment by the DELTA system.

Acknowledgements

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References

- Aiken SG, Consaul LL, Dallwitz MJ. 1996. Grasses of the Canadian Arctic Archipelago: a DELTA database for interactive identification and illustrated information retrieval. *Canadian Journal of Botany* 74: 1812–1825.
- Brown AHS, Smith G. 1957. The genus *Paecilomyces* Bainier and its perfect stage *Byssosclamyces* Westling. *Trans. Brit. mycol. Soc.* 40(1): 17–89.

- Chen CH, Kuoh CS. 2000a. The Genus *Poa* L. (Poaceae) in Taiwan: a DELTA Database for Generating Key and Description. *Taiwania* 45(2):147–157.
- Chen CH, Kuoh CS. 2000b. The application of DELTA database system on taxonomy. *Q. Jour. Chin. For.* 33(4):573–583.
- Chen QT, Xiao SR, Shi ZY. 1984. *Paecilomyces sinensis* sp. nov. and its connection with *Cordyceps sinensis*. *Acta Mycologica Sinica* 3(1): 24–28.
- Chen X. 2004. Numerical taxonomy and systematic study on the subgenera rhododendron and Hymenantes in Guizhou. Master Dissertation, Guizhou University 1–73.
- Chen X. *et al.* 2003. Systematic studies of *Festuca* (Poaceae) occurring in China compared with taxa in North America. *Can. J. Bot.* 81(10): 1008–1028.
- Chen ZA. 1991. Study on entomogenous fungus, *Paecilomyces cicadae*. *Acta Mycologica Sinica* 10: 280–287.
- Dai MX. 1998. A new species of *Paecilomyces* and its aphid-killing activity. *Mycosystema* 17(3): 209–213.
- Dallwitz M. 2000b. A comparison of Formats for Descriptive Data. 1–12.
- Dallwitz MJ, *et al.* 2000a. Principle of interactive keys. 1–62.
- Dallwitz MJ. 1974. A flexible computer program for generating identification keys. *Syst. Zool.* 23: 50–57.
- Dallwitz MJ. 1980. A general system for coding taxonomic descriptions. *Taxon* 29: 41–46.
- Dallwitz MJ. *et al.* 1995a. User's guide to INTKEY: a program for interactive identification and information retrieval. 1st edition. 1–56.
- Dallwitz MJ. *et al.* 1995b. User's guide to the DELTA system: a general system for processing taxonomic description. 4th edition 1–112.
- Fang QX, Gong YX, ZhouYY, *et al.* 1983. *Paecilomyces fumosoroseus* var. *beijingensis*. *Acta Mycologica Sinica* 2: 168–172.
- Han YF, Zhang YW, Liang JD. *et al.* 2007. A novel *Paecilomyces* species isolated from soil in China. *Mycotaxon* 102: 51–56.
- HanYF, Liang ZQ, Chu HL. *et al.* 2005. *Paecilomyces parvosporus*, a new species with its relatives from Yunnan Province, China. *Mycotaxon* 94: 357–363.
- Heywood VH. 1979. Translated by Ke ZF. *Taxonomy of Plant*. Beijing: Science Press 61–67.
- Li JJ. 1996. DELTA system—the international standard for plant taxonomy description language. *Act. Phyto. Sin.* 34(4):447–452.
- Li WY, He YC, Wang JM. *et al.* 2003. Ecological diversity of entomogenous fungi of three nature reserves in Shanxi Province. *Biodiversity Science* 11: 53–58.
- Li ZZ, Li CR, Huang B, *et al.* 1999. New variety of *Cordyceps gunnii* (Berk.) Berk. and its *Paecilomyces* anamorph. *The Korean Journal of Mycology* 27: 231–233.
- Liang ZQ, Liu AY, Feng DM. 1993. Some entomogenous fungi from Fanjing Mountain Preserve in China. *Acta Mycologica Sinica* 12(2): 110–117.
- Liang ZQ, Liu AY, Huang JZ, *et al.* 1997. The genus *Cordyceps* and its allies from Kuankuoshui Preserve in Guizhou II. *Mycosystema* 16(1): 61–67.
- Liang ZQ, Wang B, Kang JC. 2002. Several rare entopathogenic fungi from the western Sichuan mountains. *Fungal Diversity* 12: 129–134.
- Liang ZQ. 1981. Two new species of *Paecilomyces* from insects. *Acta Microbiologica Sinica* 21: 31–34.
- Liang ZQ. 1985. Isolation and identification of the conidial stage of *Cordyceps gunnii*. *Acta Mycologica Sinica* 4(3): 162–166.

- Liang ZQ. 2001. A Corroboration of the Anamorph of *Cordyceps militaris* – *Paecilomyces militaris* Liang sp. nov. *Acta Edulis Fungi* 8(4): 28–32.
- Liu AY, Liang ZQ. 2003. A new record–*Paecilomyces amoeneroseus* in China. *Mycosystema* 22(Suppl.): 80–81.
- Liu SL. 2006. Application of agriculture expert system in microorganism classification. *Hunan Agricultural Sciences* (5): 96–98, 101.
- Liu ZY, Liang ZQ, Liu AY. 1995–96. A new species of *Paecilomyces* isolated from *Cordyceps odonatae*. *Mycosystema* 8–9: 83–87.
- Luangsa-ard JJ, Hywel-Jones NL, Manoch L. et al. 2005. On the relationships of *Paecilomyces* sect. *Isarioidea* species. *Mycol. Res.* 109(5): 581–589.
- Luangsa-ard JJ, Hywel-Jones NL, Samson RA. 2004. The polyphyletic nature of *Paecilomyces sensu lato* based on 18S-generated rDNA phylogeny. *Mycologia* 96(4): 773–780.
- Michael TD. 1983. *Paecilomyces nostocoides*, a new hyphomycete isolated from cysts of *Heterodera zaeae*. *Mycologia* 75(1): 179–182.
- Samson RA. 1974. *Paecilomyces* and some allied hyphomycetes. *Studies in Mycology* 6: 1–119.
- Tzean SS, Hsieh LS, Wu WJ. 1997. *Atlas of Entomopathogenic Fungi from Taiwan*. Council of Agriculture, Executive Yuan Taiwan, R.O.C.

Taxonomic studies of *Corynespora* from Hainan, China

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Abstract — Four new species of *Corynespora* were found during a continuing survey of anamorphic fungi in tropical areas of Hainan province, China. The new species, *C. beilschmiediae*, *C. cassiae*, *C. fici-benjaminiae*, and *C. lasianthi*, occurred on the hosts *Beilschmiedia intermedia*, *Cassia surattensis*, *Ficus benjamina*, and *Lasianthus chinensis*, respectively. They are described, illustrated and compared with closely related taxa.

Key words — dematiaceous, hyphomycetes, taxonomy

Introduction

The genus *Corynespora* was described by Güssow (1906). Wei (1950) emended the diagnosis of the genus and clarified the conidiogenesis of the type species, *C. cassicola* (Berk. & M.A. Curt.) C.T. Wei. *Corynespora* is characterized by macronematous, mononematous, simple or branched conidiophores with monotretic, determinate or percurrently extending conidiogenous cells, and obclavate to slightly ellipsoid, distoseptate, solitary or catenate conidia. These characters separate *Corynespora* Güssow from similar genera, viz. *Helminthosporium* Link, *Corynesporella* Munjal & H.S. Gill, *Hemicorynespora* M.B. Ellis, *Corynesporopsis* P.M. Kirk and *Solicorynespora* R.F. Castañeda & W.B. Kendr. Conidial characters (size, shape, septation, ornamentation and, to some extent, pigmentation) and the proliferation of conidiophores have been used to distinguish species within the genus (Ellis 1957, 1976; Siboe et al. 1999). Many species in genera such as *Cercospora* Fres. and *Helminthosporium* have been transferred to *Corynespora*. Ellis (1957, 1960, 1961a, b, 1963a, b, 1971, 1976), Morgan Jones (1988), Sutton & Pascoe (1988), Meenu et al. (1997, 1998), Siboe et al. (1999), Singh et al. (2000a, b), Sharma et al. (2002) and Wulandari

*Kai Zhang and Hong-Bo Fu contributed equally to this work

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(2006) have added many species to the genus.

More than 100 species have been validly described under *Corynespora*, most of which are reported to be parasites on plant leaves, but some species survive as saprobes on dead branches, wood, etc. Twenty species have been described from China, four parasitic on plant leaves (Guo 1984), and 16 saprobic on deciduous stems or wood (Zhang et al. 2005, 2007, 2008; Ma & Zhang 2007, 2008; Shang & Zhang 2007, Wang & Zhang 2007).

Fungi were collected on dead branches or rotten wood from tropical forest in Hainan province of China during 2007. Among the collections four undescribed species of *Corynespora* were found. The type specimens are deposited in HSAUP (Herbarium of the Department of Plant Pathology, Shandong Agricultural University) with isotypes in HMAS (Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences).

Taxonomic descriptions

Corynespora beilschmiediae K. Zhang & X.G. Zhang, sp. nov.

FIGURE 1

MYCOBANK MB 511436

Coloniae fuscae, effusae. Mycelium semper superficiale, ex hyphis ramosis, septatis, subhyalinis vel brunneis, laevibus, 2–8 µm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, ex apice lateribusque hypharum oriunda, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, pallide brunnea vel brunnea, per usque ad 2 proliferationes percurrentes successivas cylindricae elongascentia, 33.5–81.5 µm longa, 3.5–5.5 µm crassa. Conidia recta vel curvata, obclavata, longe attenuata, laevia, pallide brunnea vel brunnea, 7–19-distoseptata, 52–144.5 µm longa, 8.5–11 µm crassa, apicem versus ad 3–5 µm attenuata, basi 2–3 µm lata, singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda.

HOLOTYPE: CHINA, Hainan Province, Jianfengling National Forest park, on dead branches of *Beilschmiedia intermedia* C.K. Allen, 21 May 2007, K. Zhang, HSAUPVIIo-ZK 0241 (Isotype HMAS189370).

ETYMOLOGY: In reference to the host genus, *Beilschmiedia*.

Colonies blackish brown, effused. Mycelium mostly superficial on the substratum, composed of branched, septate, subhyaline to brown, smooth-walled hyphae, 2–8 µm thick. Stroma absent. Conidiophores arising singly or in groups, terminally and laterally on the hyphae, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, pale brown to brown, with up to 2 successive percurrent cylindrical proliferations, 33.5–81.5 µm long, 3.5–5.5 µm thick. Conidia straight or curved, obclavate, tapering to the apex, smooth-walled, pale brown to brown, 7–19-distoseptate, 52–144.5 µm long, 8.5–11 µm thick in the broadest part, tapering to 3–5 µm near the apex, 2–3 µm wide at the base, formed singly through a pore at the apex of the conidiophore which, after the first conidium has fallen, sometimes proliferates through the apical pore and forms another conidium at the apex of the proliferation.

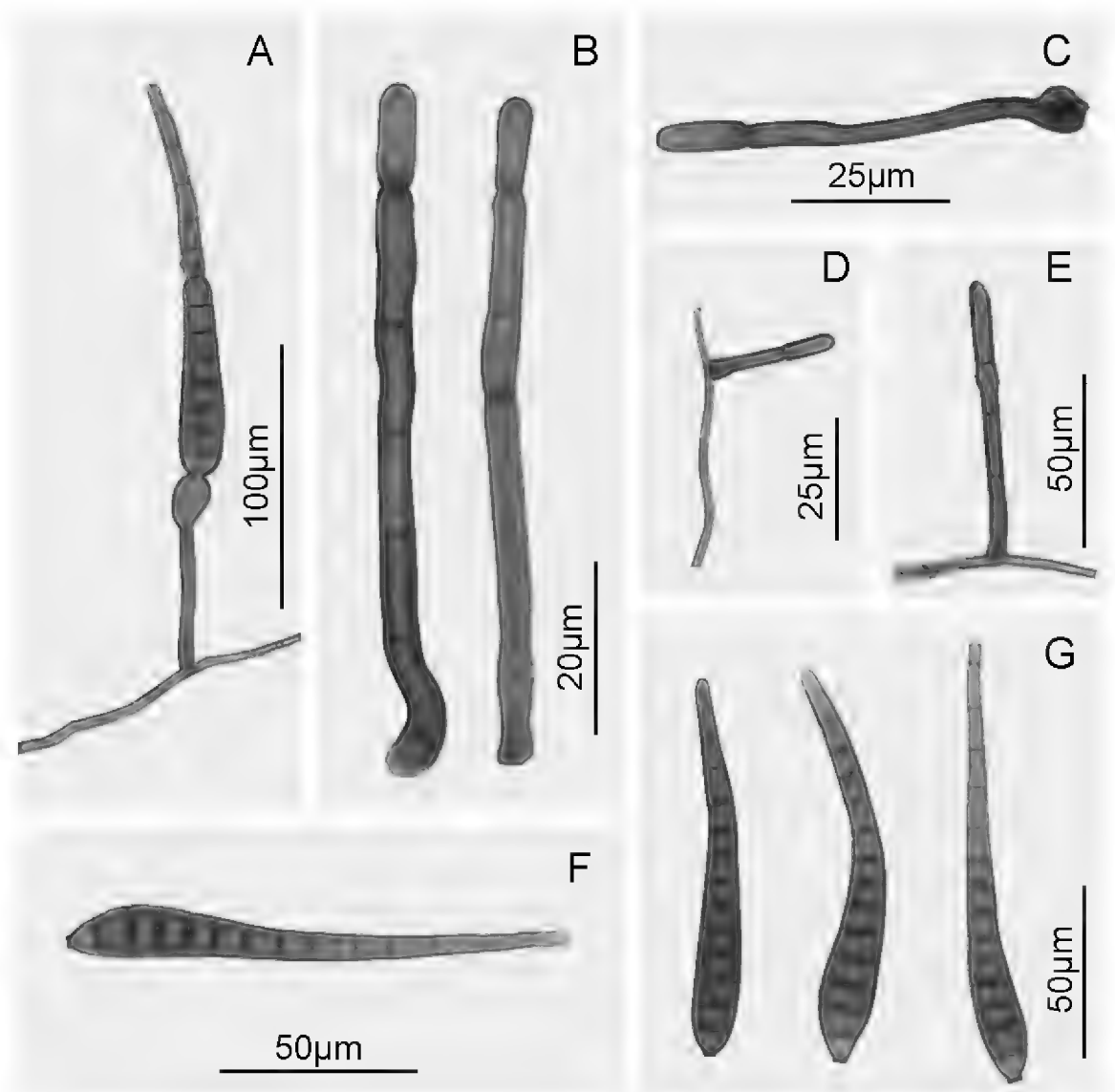


FIG. 1. *Corynespora beilschmiediae*. A. Conidiophore and conidium. B–E. Conidiophores with apex showing percurrent proliferation. F–G. Conidia.

COMMENTS: Among described species only *C. combreti* (Ellis 1963b) is similar to *C. beilschmiediae*. However, *C. beilschmiediae* differs from *C. combreti* in the size of conidiophores, which are unbranched in *C. beilschmiediae*. The width of the conidial apex and number of septa also differ in *C. beilschmiediae*.

***Corynespora cassiae* K. Zhang & X.G. Zhang, sp. nov.**

FIGURE 2

MYCOBANK MB 511437

Coloniae griseae vel fuscae, effusae. *Mycelium* superficiale, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, laevibus, 2–8 µm crassis compositum. *Stromata* nulla. *Conidiophora* singula vel fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, laevia, brunnea, septata, per usque ad 5 proliferationes percurrentes successivas cylindricae elongascentia, 133.5–217.5 µm longa, 6–10 µm crassa. *Conidia* singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel leviter curvata, pallide brunnea vel olivaceo-brunnea, obclavata, longe attenuata, laevia, 10–21-distoseptata, 107.5–214 µm longa, 11–14 µm crassa, apicem versus ad 3–4.5 µm attenuata, basi truncata 5–6.5 µm lata.

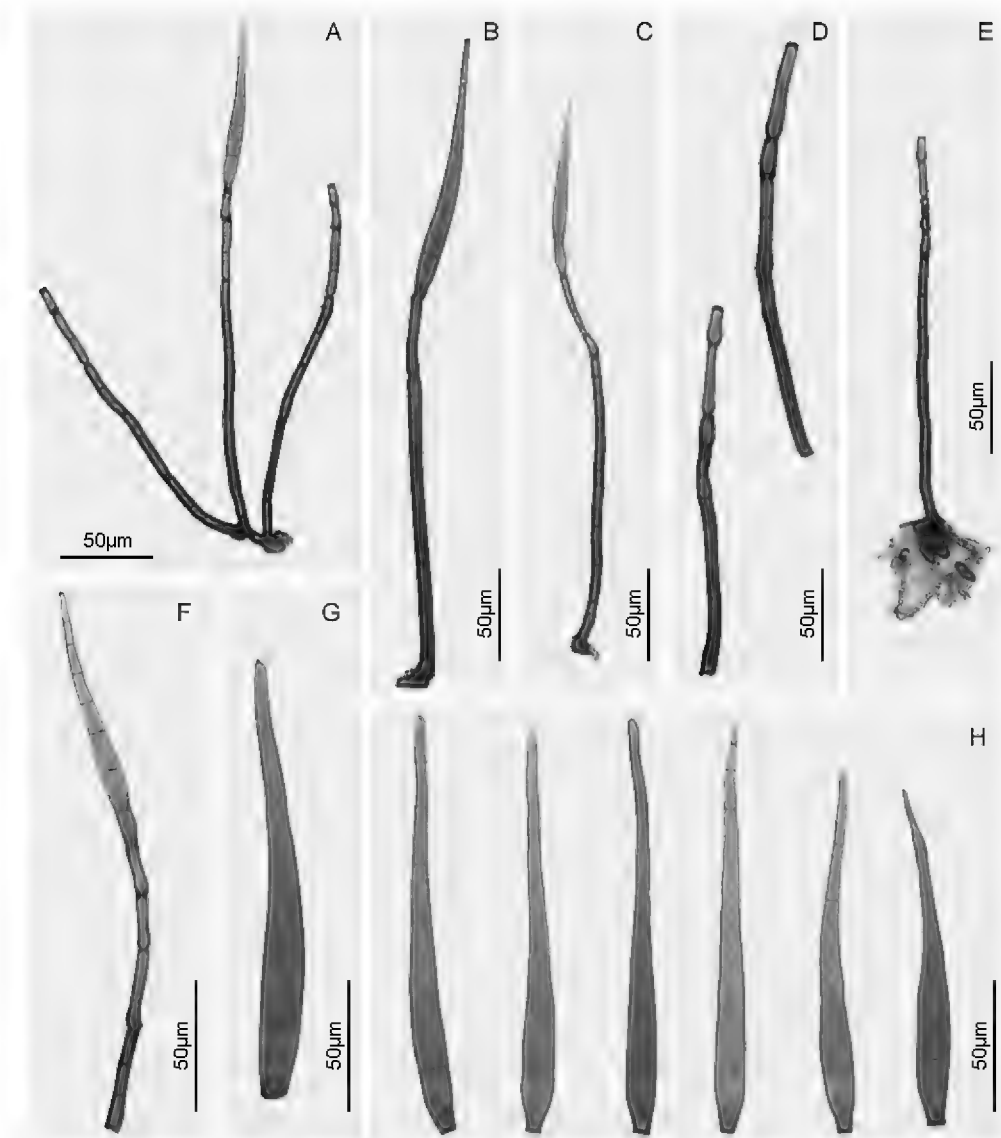


FIG. 2. *Corynespora cassiae*.

A–F. Percurrent proliferations of conidiophores with or without conidia. G–H. Conidia.

HOLOTYPE: CHINA, Hainan Province, Danzhou Tropical Arboretum, on dead branches of *Cassia surattensis* Burm. f., 28 April 2007, J. Ma, HSAUPVII_{0MJ} 0039–1 (Isotype HMAS189371).

ETYMOLOGY: In reference to the host genus, *Cassia*.

Colonies grey to blackish brown, effused. Mycelium on substratum, mostly superficial, composed of branched, septate, subhyaline to pale brown, smooth-walled hyphae, 2–8 µm thick. Stroma absent. Conidiophores arising singly or in groups, erect, unbranched, straight or flexuous, cylindrical, smooth-walled, brown, septate, with up to 5 successive percurrent cylindrical proliferations, 133.5–217.5 µm long, 6–10 µm thick. Conidia formed singly through a pore at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia straight or slightly curved, pale brown to olivaceous brown, becoming gradually paler towards the apex, obclavate, tapering to the apex, smooth-walled, 10–21-

distoseptate, 107.5–214 µm long, 11–14 µm thick in the broadest part, tapering to 3–4.5 µm near the apex, 5–6.5 µm wide at the truncate basal scar.

COMMENTS: *C. calicioidea* (Ellis 1957) and *C. polyphragmia* (Ellis 1961b) resemble the present species. The conidiophores of *C. cassiae* are shorter than those of *C. calicioidea* and *C. polyphragmia*. The conidiophores of *C. cassiae* proliferate up to 5 times while those of *C. calicioidea* and *C. polyphragmia* proliferate 8 and 6 times, respectively. The conidia of *C. cassiae* are slightly longer than those of *C. calicioidea* (50–170 µm) and narrower than in *C. polyphragmia* (14–17 µm). *Corynespora cassiae* conidia have an unthickened hilum as against obviously thickened hila in both *C. calicioidea* and *C. polyphragmia*. The conidial base of *C. calicioidea* is narrower than that of *C. cassiae* and *C. polyphragmia*.

***Corynespora fici-benjaminiae* H.B. Fu & X.G. Zhang, sp. nov.**

FIGURE 3

MYCOBANK MB 511438

Coloniae fuscae vel atrae, pilosae, effusae. Mycelium partim superficiale sed fere immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, laevibus, 2–5 µm crassis compositum. Stromata nulla. Conidiophora singular, interdum caespitosa, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, brunnea vel atro-brunnea, per usque ad 3 proliferationes successivas cylindricae elongascentia, 152–467 µm longa, 5.5–11 µm crassa. Conidia recta vel leviter curvata, obclavata, laevia, pallide olivaceo-brunnea, 5–10-distoseptata, 51.5–71 µm longa, 8–11 µm crassa, apicem versus ad 2–3.5 µm attenuata, basi 3–4.5 µm lata. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda,

HOLOTYPE: CHINA, Hainan Province, tropical forest of Wuzhishan, on dead branches of *Ficus benjamina* L., H.B. Fu, 5 May 2007, HSAUPVII0-FU0454 (Isotype HMAS189372).

ETYMOLOGY: In reference to the host genus, *Ficus*.

Colonies blackish brown to black, hairy, effused. Mycelium partly superficial, but mostly immersed in the substratum, composed of branched, septate, subhyaline to pale brown, smooth-walled hyphae, 2–5 µm thick. Stroma absent. Conidiophores arising singly, sometimes caespitose, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, brown to dark brown, with up to 3 successive cylindrical proliferations, 152–467 µm long, 5.5–11 µm thick. Conidia straight or slightly curved, obclavate, smooth-walled, pale olivaceous brown, 5–10-distoseptate, 51.5–71 µm long, 8–11 µm thick in the broadest part, tapering to 2–3.5 µm near the apex, 3–4.5 µm wide at the base. Conidia formed singly through a pore at the apex of the conidiophore which, after the first conidium has fallen, sometimes proliferates through the apical pore and forms another conidium at the new apex.

COMMENTS: *C. fici-benjaminiae* resembles *C. calicioidea*, *C. gigaspora* (Ellis 1957) and *C. fici-altissimae* (Zhang & Xu 2005) in conidiophore structure and conidial shape of conidia, except that the *C. fici-benjaminiae* conidiophores are smaller than in *C. calicioidea* and *C. gigaspora* and larger than in *C. fici-*

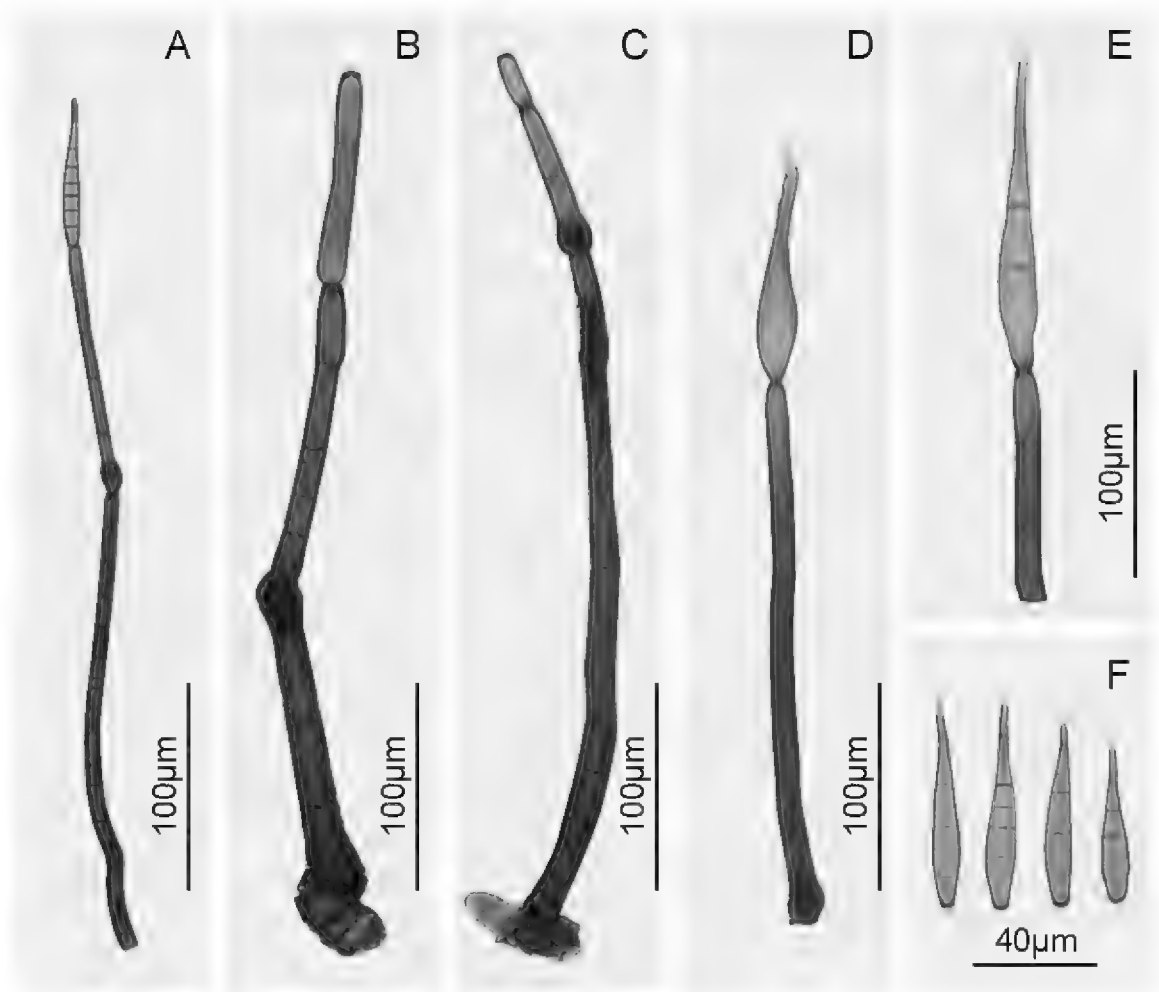


FIG. 3. *Corynespora fici-benjaminiae*.
A–E. Conidiophores with or without conidia. F. Conidia.

altissimage. The *C. calicioidea* conidiophores proliferate up to 8 times while those of *C. fici-benjaminiae*, *C. gigaspora*, and *C. fici-altissimage* proliferate only 3 times. In addition, the conidial size and number of septa differ from *C. calicioidea* (50–170 × 10–15 µm, 6–21-distoseptate) and *C. gigaspora* (100–270 × 19–28 µm, 9–52-distoseptate). In addition, the *C. fici-benjaminiae* conidia have fewer septa (5–10) than those of *C. fici-altissimage* (11–18). Therefore, the present fungus is treated as a new taxon of species rank.

***Corynespora lasianthi* H.B. Fu & X.G. Zhang, sp. nov.**

FIGURE 4

MYCOBANK MB 511439

Coloniae coloniae fuscae, effusae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, laevibus, 2–6 µm crassis compositum. Stromata nulla. Conidiophora interdum singula sed fere fasciculata, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, brunnea vel atro-brunnea, per usque ad 3 proliferationes percurrentes successivas cylindricae elongascentia, 119–159 µm longa, 4.5–7.5 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel leviter curvata, obclavata, laevia, interdum rostrata, pallide brunnea vel atro-brunnea, 4–8-distoseptata, 50–103.5 µm longa, 8.5–10 µm crassa, apicem versus ad 3–4 µm attenuata, basi truncata 3–4.5 µm lata.

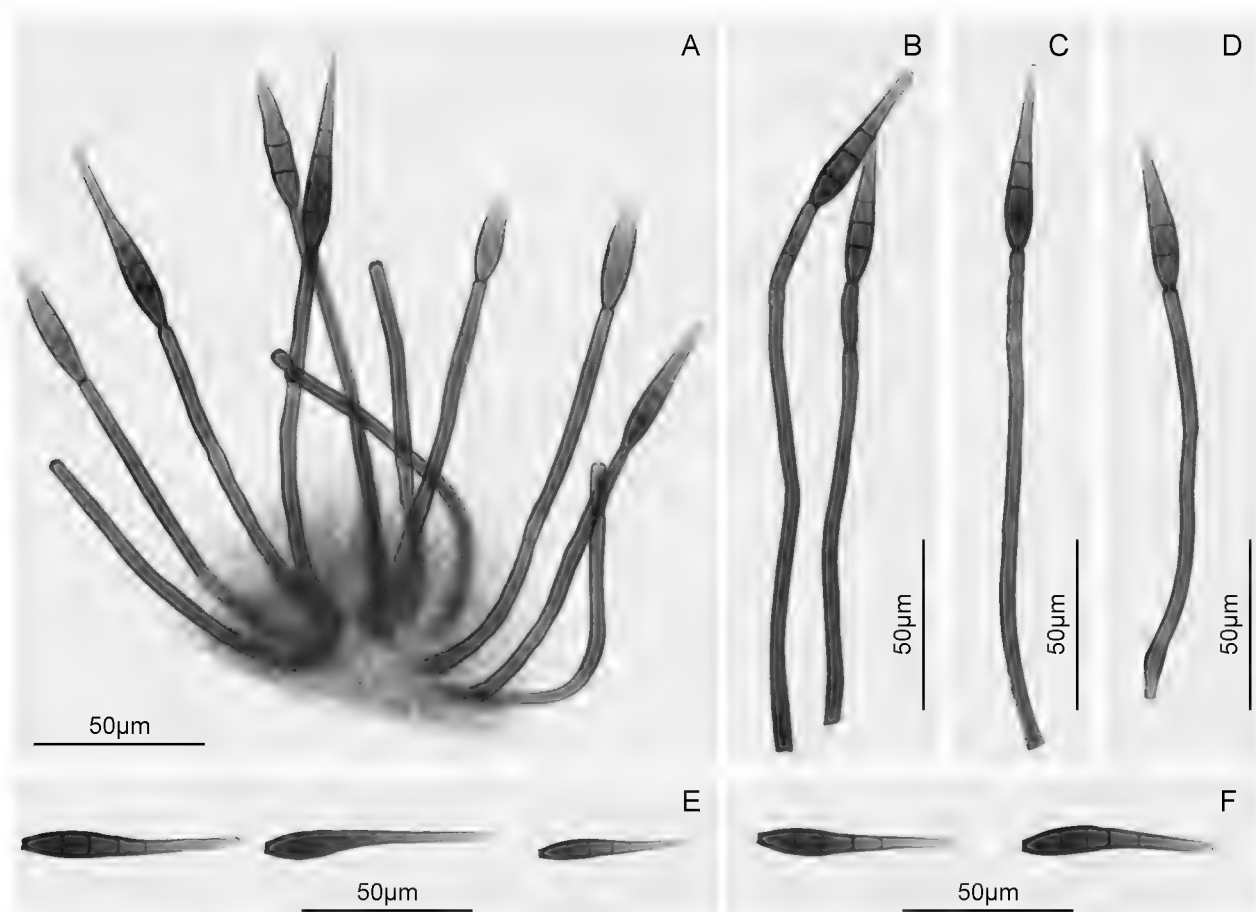


FIG. 4. *Corynespora lasianthi*.
A–D. Conidiophores and conidia. E–F. Conidia.

HOLOTYPE: CHINA, Hainan Province, tropical forest of Wuzhishan, on dead branches of *Lasianthus chinensis* Benth., H.B. Fu, 10 May 2007, HSAUPVII₀-FU0157 (Isotype HMAS196882).

ETYMOLOGY: In reference to the host genus, *Lasianthus*.

Colonies blackish brown, effused. Mycelium superficial and immersed in the substratum, composed of branched, septate, subhyaline to pale brown, smooth-walled hyphae, 2–6 µm thick. Stroma absent. Conidiophores in fascicles, sometimes single, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, brown to dark brown, with up to 3 successive percurrent cylindrical proliferations, 119–159 µm long, 4.5–7.5 µm thick. Conidia formed singly through a pore at the apex of the conidiophore which, after the first conidium has fallen, sometimes proliferates through the apical pore and forms another conidium at the apex of the conidiophore. Conidia straight or slightly curved, obclavate, smooth-walled, sometimes rostrate, pale brown to dark brown, becoming gradually paler toward the apex, 4–8-distoseptate, 50–103.5 µm long, 8.5–10 µm thick in the broadest part, tapering to 3–4 µm near the apex, 3–4.5 µm wide at the truncate basal scar.

COMMENTS: *C. lasianthi* shows some affinities with *C. flagellata* (Zhang & Ji 2005) and *C. tanacetii* (Zhang & Zhang 2007) in number of conidiophore

proliferations, dimension of conidiophores, and length of conidia. However, *C. lasianthi* conidia are smooth, while those of *C. flagellata* are verrucose and those of *C. tanacetii* are smooth or verrucose. The *C. lasianthi* conidia are narrower than *C. flagellata* and *C. tanacetii* conidia and have fewer septa (4–8) than those of *C. flagellata* (5–10) and *C. tanacetii* (7–12). Therefore, the present collection is sufficiently distinct to be recognized as a new taxon of species rank.

Acknowledgments

The authors are grateful to Prof. D.J. Bhat and Dr. Eric H.C. McKenzie for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (No. 30770015, 30499340, 2006FY120100).

Literature cited

- Ellis MB. 1957. Some species of *Corynespora*. Mycological Papers 65: 1–15.
- Ellis MB. 1960. Dematiaceous hyphomycetes. I. Mycological Papers 76: 19–34.
- Ellis MB. 1961a. Dematiaceous hyphomycetes. II. Mycological Papers 79: 1–23.
- Ellis MB. 1961b. Dematiaceous hyphomycetes. III. Mycological Papers 82: 1–55.
- Ellis MB. 1963a. Dematiaceous hyphomycetes. IV. Mycological Papers 87: 1–42.
- Ellis MB. 1963b. Dematiaceous hyphomycetes. V. Mycological Papers 93: 1–33.
- Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England. 608pp.
- Ellis MB. 1976. More Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England. 507pp.
- Guo YL. 1984. Four new species of the genus *Corynespora*. Acta Mycologica Sinica 3: 161–169.
- Güssow HT. 1906. Über eine neue Krankheit der Gurken in England (*Corynespora mazei*, Güssow gen. et sp. nov.). Zeitschrift für Pflkrankheiten 16: 10–13.
- Ma J, Zhang K, Zhang XG. 2008. Taxonomic studies of *Corynespora* from Hainan, China. Mycotaxon 104: 153–157.
- Ma J, Zhang XG. 2007. Three new species of *Corynespora* from China. Mycotaxon 99: 353–358.
- Meenu, Kamal. 1998. New species of *Corynespora*. Mycological Research 102: 344–346.
- Meenu, Kharwar RN, Bhartiya HD. 1998. Some new forms of genus *Corynespora* from Kathmandu Valley of Nepal. Indian Phytopathology 51: 146–151.
- Meenu, Singh A, Singh SK. 1997. Some new species of *Corynespora*. Indian Phytopathology 50: 17–24.
- Morgan-Jones G. 1988. Notes on hyphomycetes LX. Mycotaxon 33: 483–489.
- Shang ZQ, Zhang XG. 2007. Two new species of *Corynespora* from Jiangsu, China. Mycotaxon 100: 155–158.
- Siboe GM, Kirk PM, Cannon PF. 1999. New dematiaceous hyphomycetes from Kenyan rare plants. Mycotaxon 73: 283–302.
- Sutton BC, Pascoe IG. 1988. Some dematiaceous hyphomycetes from branches and phyllodes of *Acacia* in Australia. Australian Systematic Botany 1: 127–138.
- Wang XM, Zhang XG. 2007. A new species of *Corynespora* from Yunnan, China. Mycotaxon 101: 79–81.

- Wei CT. 1950. Notes on *Corynespora*. Mycological Papers 34: 1–10.
- Zhang GM, Zhang XG. 2007. Two new species of *Corynespora* from Guangdong, China. Mycotaxon 99: 347–351.
- Zhang K, Ma J, Zhang XG. 2008. Two new species of *Corynespora* from Hainan, China. Mycotaxon 104: 159–163.
- Zhang XG, Ji M. 2005. Taxonomic studies of *Corynespora* from Yunnan, China. Mycotaxon 92: 425–429.
- Zhang XG, Shi CK. 2005. Taxonomic studies of *Corynespora* from China. Mycotaxon 92: 417–423.
- Zhang XG, Xu JJ. 2005. Taxonomic studies of *Corynespora* from Guangxi, China. Mycotaxon 92: 431–436.

Taxonomic studies of *Minimelanolocus* from Yunnan, China

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Abstract — Three new species of *Minimelanolocus* from dead branches are described and illustrated. The specimens were collected from tropical forest in Yunnan province of China. Two new records of *Minimelanolocus* are noted from the same area. The type specimens are deposited in HSAUP (Herbarium of the Department of Plant Pathology, Shandong Agricultural University) with isotypes in HMAS (Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences).

Key words — anamorphic fungi, taxonomy

Introduction

Castañeda & Heredia (2001) segregated *Minimelanolocus* from *Pseudospiropes* M.B. Ellis (1971), *Helminthosporium* Link (1809), and *Belemnospora* P.M. Kirk (1981) for 12 previously described species characterized as having holoblastic, polyblastic, indeterminate, terminal becoming intercalary, integrated conidiogenous cells with holoblastic sympodial extensions and inconspicuous or slightly prominent, narrow, opaque, refractive to somewhat obscure dehiscence scars, and euseptate conidia. Those characters differentiate *Minimelanolocus* from similar genera including *Nigrolentilocus* R.F. Castañeda & Heredia and *Matsushimiella* R.F. Castañeda & Heredia.

Most species of *Minimelanolocus* are saprobes on rotten leaves or dead branches. Only two species, *M. endospermi* and *M. pterocerpi*, have been reported from China (Ma et al. 2008).

A survey of the saprobic fungi on dead wood from tropical forest in Yunnan province, China revealed three previously undescribed species and two new records of *Minimelanolocus*.

*Kai Zhang and Hong-Bo Fu contributed equally to this work

**Corresponding author

Taxonomic descriptions

Minimelanolocus magnoliae K. Zhang & X.G. Zhang, sp. nov.

FIGURE 1

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Coloniae effusae in substrato naturali, olivaceo-brunneae vel fuscae, pilosae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, pallide brunnea vel brunnea, laevibus, 1–2 μm crassis compositum. Conidiophora macronematosi, mononematosi, singula, interdum caespitosa, nonramosa, erecta, recta vel flexuosa, laevia, brunnea, apice versus pallidiora, 12–17-septata, 220–500 μm longa, 5–7.5 μm crassa. Cellulae conidiogenae holoblasticae, polyblasticae, in conidiophoris incorporatae, indeterminatae, sympodialiter extendentes, terminales deinde intercalares, pallide brunneae. Loci conidiogeni inconspicui vel leviter prominentibus, refractivi. Conidia solitaria, acropleurogena, simplicia, ellipsoidea vel cylindrica, basi truncata, pallide

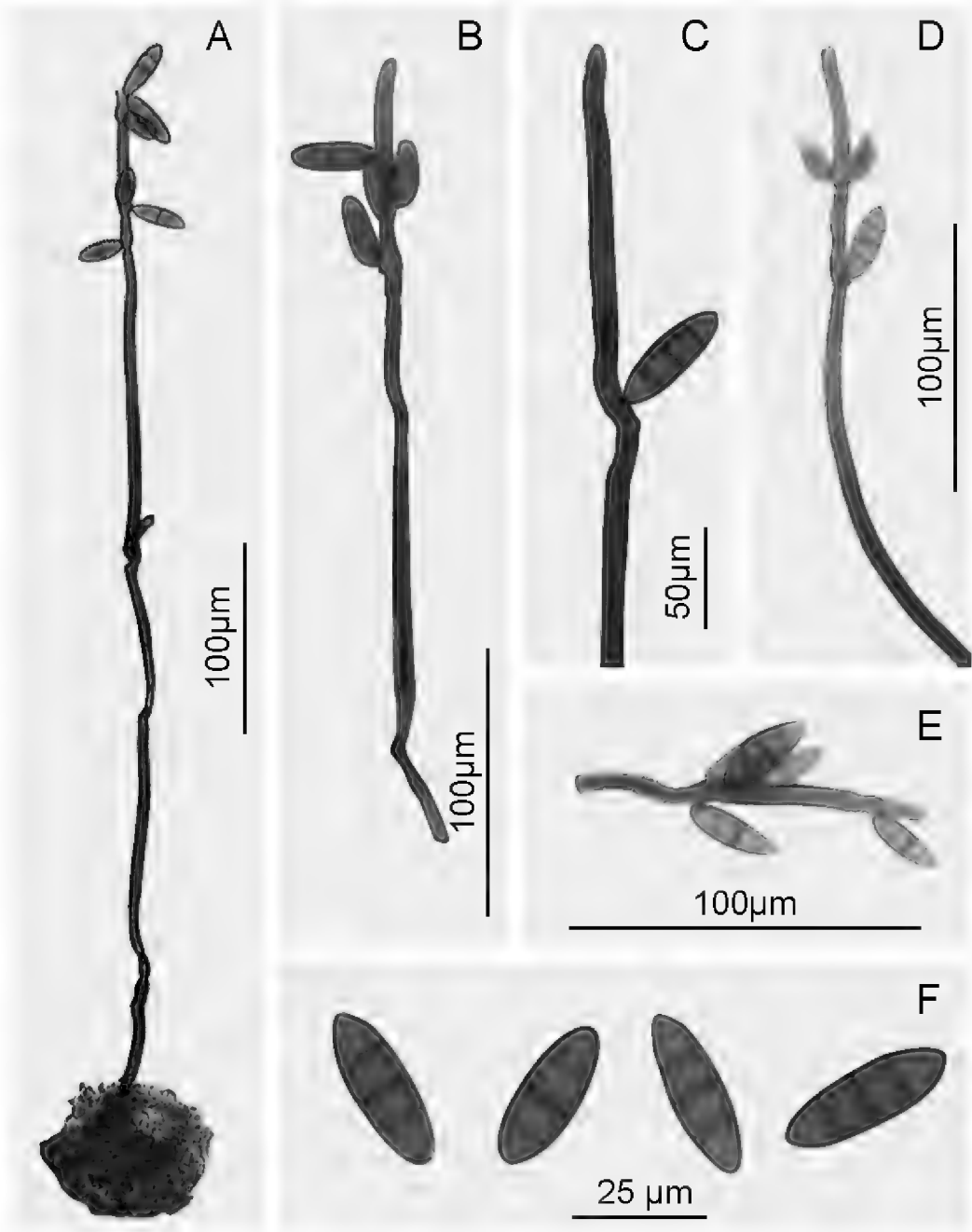


FIG. 1. *Minimelanolocus magnoliae*.
A–E. Conidiophores with conidia. F. Conidia.

brunnea vel *brunnea*, *laevia*, *plerumque* 3-euseptata, *raro* 2-euseptata, 29–38 μm longa, 10–11 μm crassa, *basi truncata* 1–2 μm lata, *conidiorum secession schizolytica*.

HOLOTYPE: On dead branches of *Magnolia paenetaula* Dandy, forest of Daweishan, Yunnan Province, China, 15 Oct 2007, Kai Zhang, HSAUPVII₀-ZK1277-1 (Isotype HMAS196885).

ETYMOLOGY: In reference to the host genus, *Magnolia*.

Colonies effuse on natural substratum, olivaceous brown to blackish brown, hairy. Mycelium partly superficial, partly immersed, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 1–2 μm thick. Conidiophores macronematous, mononematous, sometimes caespitose, unbranched, erect, straight or flexuous, smooth, brown, paler towards apex, 12–17-septate, 220–500 μm long, 5–7.5 μm thick. Conidiogenous cells polyblastic, integrated, indeterminate, sympodially extending, terminal becoming intercalary, pale brown. Conidiogenous loci inconspicuous or slightly prominent, refractive. Conidia solitary, acropleurogenous, simple, ellipsoidal or cylindrical, truncate at the base, pale brown to brown, smooth-walled, mostly 3-euseptate, rarely 2-euseptate, 29–38 μm long, 10–11 μm thick in the broadest part, 1–2 μm wide at the truncate base, conidial secession schizolytic.

COMMENTS: The conidia of this species are similar to *M. bambusae*, *M. hughesii*, and *M. leptotrichus* (Castañeda & Heredia 2001) in having 3 or fewer septa. However, the *M. magnoliae* conidia are larger than those of *M. bambusae* (15–19 \times 6–7 μm), *M. hughesii* (12–18 \times 4.5–6 μm), and *M. leptotrichus* (16–22 \times 7–10 μm). In addition, the mature *M. magnoliae* conidia are brown while those of *M. leptotrichus* and *M. bambusae* are subhyaline to pale brown.

***Minimelanolocus machili* K. Zhang & X.G. Zhang, sp. nov.**

FIGURE 2

MYCOBANK MB 513111

Coloniae effusae in substrato naturali, atro-brunneae, pilosae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus, 2–3 μm crassis compositum. Conidiophora macronematosa, mononematosa, solitaria, nonramosa, erecta, recta vel flexuosa, laevia, atro-brunnea, apice versus pallidiora, 9–12-septata, 245–305 μm longa, 5.5–6.5 μm crassa. Cellulae conidiogenae holoblasticae, polyblasticae, in conidiophoris incorporatae, indeterminatae, sympodialiter extendentes, terminales deinde intercalares, brunnea. Loci conidiogeno inconspicuo vel leviter prominentibus, subobscurus. Conidia solitaria, acropleurogena, simplicia, apice rotundata, ad basim truncata, brunnea, cellula basali et partim pallide brunnea, laevia, 3-euseptata, 26–40 μm longa, 8.5–12 μm crassa. Basi truncata 2–3 μm lata, conidiorum secessio schizolytica.

HOLOTYPE: On dead branches of *Machilus grijsii* Hance, tropical forest of Banna, Yunnan Province, China. 12 Oct 2007, Jian Ma, HSAUPV₀MJ 0565 (Isotype HMAS196886).

ETYMOLOGY: In reference to the host genus, *Machilus*.

Colonies effuse on natural substratum, dark brown, hairy. Mycelium partly superficial, partly immersed, composed of branched, septate, pale brown,

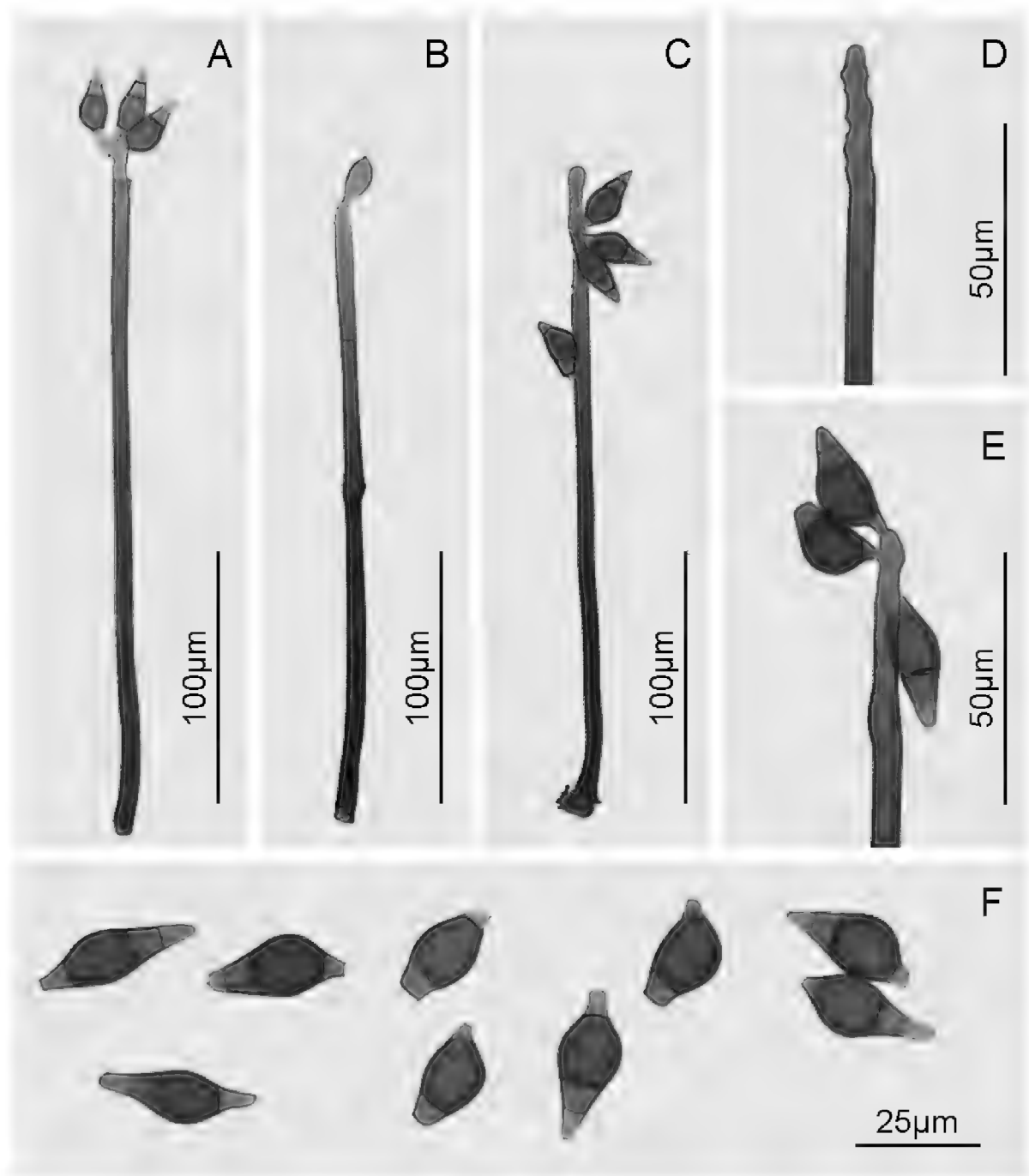


FIG. 2. *Minimelanolocus machili*.
A–E. Conidiophores with or without conidia. F. Conidia.

smooth-walled hyphae, 2–3 µm thick. Conidiophores macronematous, mononematous, unbranched, erect, straight or flexuous, smooth, dark brown, paler towards apex, 9–12-septate, 245–305 µm long, 5.5–6.5 µm thick. Conidiogenous cells polyblastic, integrated, indeterminate, sympodially extending, terminal becoming intercalary, brown. Conidiogenous loci inconspicuous or slightly prominent, somewhat obscure. Conidia solitary, acropleurogenous, simple, apex rounded, base truncate, brown except for the basal cell and the apex which are pale brown, smooth-walled, 3-euseptate, 26–40 µm long, 8.5–12 µm thick in the broadest part, 2–3 µm wide at the truncate base, conidial secession schizolytic.

COMMENTS: The conidia of this species are similar to *M. dumeti* and *M. navicularis* (Castañeda & Heredia 2001). However, *M. machili* conidia are larger than those of *M. dumeti* ($15\text{--}26 \times 5.5\text{--}7.5 \mu\text{m}$) and *M. navicularis* ($20\text{--}25 \times 6\text{--}8 \mu\text{m}$). In addition, the *M. machili* conidia are 3-septate while those of *M. dumeti* are only 2-septate.



FIG. 3. *Minimelanolocus camelliae*.
A–B. Conidiophores and conidia. C. Conidia.

***Minimelanolocus camelliae* H.B. Fu & X.G. Zhang, sp. nov.**

FIGURE 3

MYCOBANK MB 513112

Coloniae effusae in substrato naturali, atro-brunneae, pilosae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus, $1.5\text{--}2 \mu\text{m}$ crassis compositum. Conidiophora macronematos, mononematos, solitaria, nonramosa, erecta, recta vel flexuosa, laevia, atro-brunnea, apice versus pallidiora, 6–13-septata, $190\text{--}365 \mu\text{m}$ longa, $5.5\text{--}7.5 \mu\text{m}$ crassa. Cellulae conidiogenae holoblasticae, polyblasticae, in conidiophoris incorporatae, indeterminatae, sympodialiter extendentes, terminales deinde intercalares, brunnea. Loci conidiogeno inconspicuo vel leviter prominentibus, subobscurus. Conidia solitaria, acropleurogena, simplicia, apice rotundata, ad basim truncata, brunnea, laevia, 3-euseptata, $23\text{--}33 \mu\text{m}$ longa, $4.5\text{--}5.5 \mu\text{m}$ crassa. Basi truncata $1\text{--}2 \mu\text{m}$ lata, conidiorum secessio schizolytica.

HOLOTYPE: On dead branches of *Camellia japonica* L., tropical forest of Banna, Yunnan Province, China. 13 Oct 2007, Hong-Bo Fu, HSAUPVII0-ZK1097-1 (Isotype HMAS196887).

ETYMOLOGY: In reference to the host genus, *Camellia*.

Colonies effuse on natural substratum, dark brown, hairy. Mycelium partly superficial, partly immersed, composed of branched, septate, pale brown, smooth-walled hyphae, 1.5–2 µm thick. Conidiophores macronematous, mononematous, unbranched, erect, straight or flexuous, smooth, dark brown, paler towards the apex, 6–13-septate, 190–365 µm long, 5.5–7.5 µm thick. Conidiogenous cells polyblastic, integrated, indeterminate, sympodial, terminal becoming intercalary, brown. Conidiogenous loci inconspicuous or slightly prominent, somewhat obscure. Conidial secession schizolytic. Conidia solitary, acropleurogenous, simple, apex rounded, base truncate, brown, smooth-walled, 3-euseptate, 23–33 µm long, 4.5–5.5 µm thick in the broadest part, 1–2 µm wide at the truncate base, conidial secession schizolytic.

COMMENTS: The conidia of *M. camelliae* are similar to those of *M. dumeti* (Castañeda & Heredia 2001) but they differ in dimensions (23–33 × 4.5–5.5 µm vs. 15–26 × 5.5–7.5 µm).

New records for China

Minimelanolocus miscanthi (Matsush.) R.F. Castañeda & Heredia, Cryptogamie Mycologie 22: 10. 2001.

On dead branches of *Melicope triphylla* (Lam.) Merr., Forest of Daweishan, Yunnan Province, China, 12 Oct 2007, Kai Zhang, HSAUPVII0-ZK1423 (duplicate HMAS196888).

Minimelanolocus rousselianus (Mont.) R.F. Castañeda & Heredia, Cryptogamie Mycologie 22: 10. 2001.

On dead branches of *Rosa rugosa* Thunb., Forest of Daweishan, Yunnan Province, China, 10 Oct 2007, Kai Zhang, HSAUPVII0-ZK1159 (duplicate HMAS196889).

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Literature cited

Castañeda Ruíz RF, Heredia G, Reyes M, Arias RM, Decock C. 2001. A revision of the genus *Pseudospiropes* and some new taxa. Cryptogamie Mycologie 22: 3–18.

- Castañeda Ruíz RF, Guarro J, Velásquez-Noa S, Gené J. 2003. A new species of *Minimelanolocus* and some hyphomycete records from rain forests in Brazil. *Mycotaxon* 85: 231–239.
- Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.
- Kirk PM, Spooner BM. 1984. An account of the fungi of Arran, Gigha and Kintyre. *Kew Bulletin* 38: 503–597.
- Ma J, Zhang K, Zhang XG. 2008. Two new species of the genus *Minimelanolocus* in China. *Mycotaxon* 104: 147–151.

***Septobasidium maesae* sp. nov. (Septobasidiaceae) from China**

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Abstract—A new species, *Septobasidium maesae* on *Maesa perlarius* associated with *Pinnaspis* sp. and *Diaspidiotus* sp. (Diaspididae), is described. It was collected from Wuzhi Mountain, Hainan Province, China.

Key words—Pucciniomycetes, Septobasidiales, taxonomy

An undescribed *Septobasidium* species on *Maesa perlarius* was found in Wuzhi Mountain National Nature Reserve in Hainan Province, tropical China in November 2008. It was associated with two kinds of scale insects, *Pinnaspis* sp. and *Diaspidiotus* sp., belonging to the family Diaspididae. This species is similar to *Septobasidium filiforme* Couch ex L.D. Gómez & Henk (Gómez & Henk 2004) but differs in producing thicker basidiomata, only 4-celled basidia, and a single layer including pillar and the hymenium. *Septobasidium filiforme* has 4-celled, 3-celled, or 2-celled basidia and a number of layers including pillars and the hymenia. In addition, the new species has brown coloured basidia and basidiospores, whereas *S. filiforme* has hyaline basidiospores. We describe the new species as:

***Septobasidium maesae* C.X. Lu & L. Guo, sp. nov.**

FIGS. 1–7

MYCOBANK MB 513274

Basidioma resupinatum, perenne, 1.5–26 × 0.8–6 cm diam., cinerascentibrunneum, margine albidum, determinatum, 1–4 mm latum; superficie laeve, maturitate rimosum separabileque, tunc stratum columnarum emergens, in sectione primum 465–525 µm crassum, deinde 1105–1720 µm crassum, e partibus tribus compositum: 1) subiculum 15–

*corresponding author

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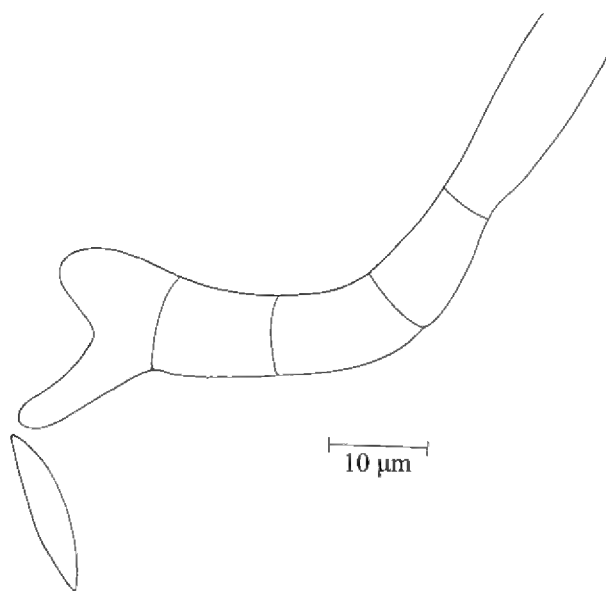


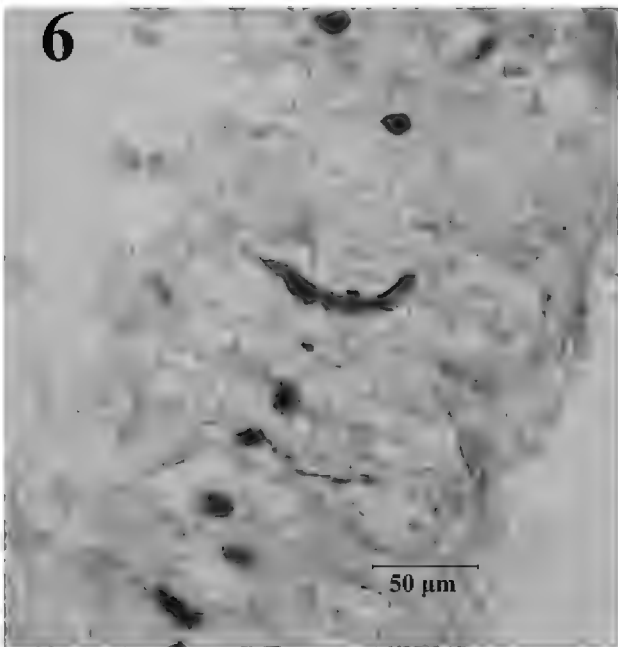
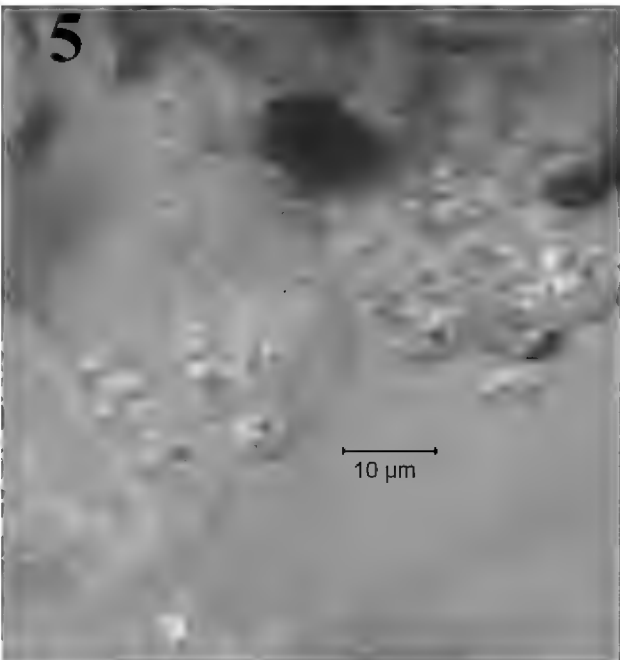
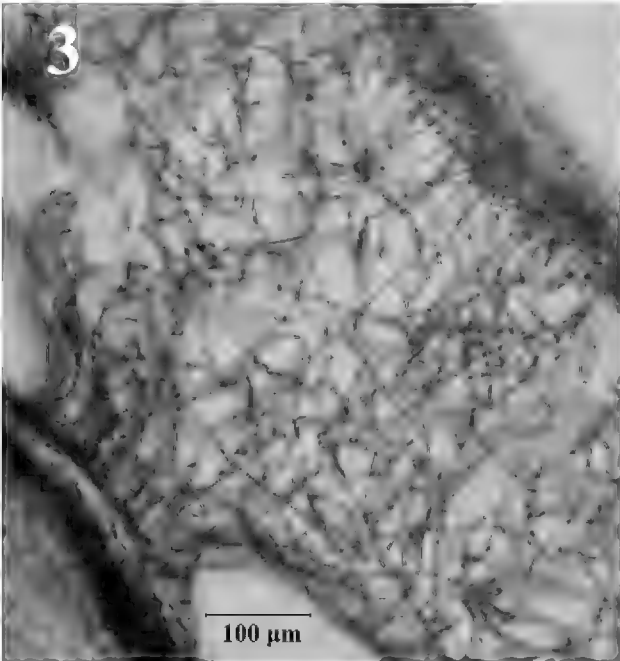
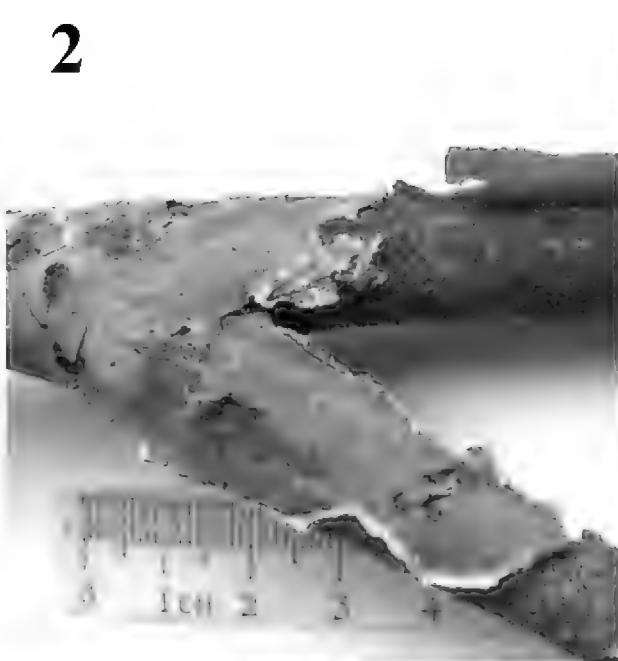
FIG. 1. A basidium and a basidiospore of *Septobasidium maesae* (HMAS 184981, holotype).

27 μm crassum; 2) *pars columnae usque ad* 1030–1460 μm longa; 3) *hymenium* 60–235 μm crassum; *probasidia obovoidea* 10–15 \times 6–9 μm , *hyalina vel brunneola, persistentia*; *basidia cylindrica, curvata, 4-cellularia*, 28–55 \times 7.5–11.5 μm , *brunnea*; *sterigmata conica*, ca. 12 μm longa; *basidiosporae fusiformes*, 18–19.5 \times 4–5 μm , *brunneolae*.

TYPE: On *Maesa perlarius* (Lour.) Merr. (*Myrsinaceae*): China, Hainan, Wuzhi Mountain, alt. 700 m, 28.XI.2008, S.H. He, Y.F. Zhu & L. Guo 2515, HMAS 184981 (holotype), associated with *Pinnaspis* sp. and *Diaspidiotus* sp. (*Diaspididae*).

Basidiomata on branches and trunks, resupinate, perennial, 1.5–26 \times 0.8–6 cm in diam., greyish-brown; margin white, determinate, 1–4 mm wide; surface smooth, becoming cracked and peeled off after maturity; usually the cracked edges curling back, a layer of brown pillars emerging. In section 465–525 μm thick in young stage, up to 1105–1720 μm thick in old stage, composed of three layers: (1) a subiculum, 15–27 μm thick; (2) a region of pillars with pillars stubby, branched outwards at the top in young stage; hyphae of young pillars 2.5–3 μm thick, becoming slender and tall, up to 1030–1460 μm long and sparingly branched in old stage; hyphae of mature pillars 5–6 μm thick, (3) hymenium 60–235 μm thick in maturity; probasidia obovoid, 10–15 \times 6–9 μm , hyaline or brownish; probasidial cell remaining after the formation of the basidia; basidia cylindrical, curved, 4-celled, 28–55 \times 7.5–11.5 μm , brown; sterigmate conical, brown, up to 12 μm long; basidiospores fusiform, 18–19.5 \times 4–5 μm , brown. Haustoria consisting of irregularly coiled hyphae.

FIGS. 2–7 (right). *Septobasidium maesae* (HMAS 184981, holotype). 2. Basidiomata on branches. 3. Section in young stage. 4. Pillars in old stage. 5. Probasidia. 6. Hymenium. 7. Basidium with a persisting probasidium, sterigma, and basidiospore.



To date, 15 species of *Septobasidium* are reported in China (Sawada 1931, 1933, Couch 1938, Teng 1963, Tai 1979, Kirschner & Chen 2007). They are *Septobasidium acaciae* Sawada, *S. albidum* Pat., *S. bogoriense* Pat., *S. carbonaceum* Pat., *S. carestianum* Bres., *S. citricola* Sawada, *S. formosense* Couch ex L.D. Gómez & Henk, *S. humile* Racib., *S. leucostemum* Pat., *S. parlatoriae* Sawada, *S. petchii* Couch. ex L. D. Gómez & Henk, *S. reinkingii* Couch ex L.D. Gómez & Henk, *S. sinense* Couch ex L.D. Gómez & Henk, *S. tanakae* (Miyabe) Boedijn & B.A. Steinm., and the new species in this paper. In China there are undoubtedly many species of *Septobasidium* yet to be discovered. Extensive collecting of the genus is required for this vast country, especially in tropical and subtropical regions.

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Literature cited

- Couch JN. 1938. The Genus *Septobasidium*. Univ. of North Carolina Press, Chapel Hill. 480 p.
- Gómez LD, Henk DA. 2004. Validation of the species of *Septobasidium* (*Basidiomycetes*) described by John N. Couch. *Lankesteriana* 4: 75–96.
- Kirschner R, Chen CJ. 2007. New reports of two hypophyllous *Septobasidium* species from Taiwan. *Fung Sci* 22(1,2): 39–46.
- Sawada K. 1931. Descriptive catalogue of the Formosan fungi. Part V. Rep. Dept. Agric. Govt. Res. Inst. Formosa. 51: 1–131.
- Sawada K. 1933. Descriptive catalogue of the Formosan fungi. Part VI. Rep. Dept. Agric. Govt. Res. Inst. Formosa. 61: 1–99.
- Tai FL. 1979. *Sylloge Fungorum Sinicorum*. Science Press, Beijing. 1527 p.
- Teng SC. 1963. *Fungi of China*. Science Press, Beijing. 808 p.

Santa Catarina Island mangroves 4 – xylophilous basidiomycetes

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Abstract — Itacorubi, Ratones, Rio Tavares and Saco Grande are natural mangrove forests in the western part of Santa Catarina Island, in southern Brazil. Thirty-three basidiomycetes were identified during a survey of xylophilous basidiomycetes in these mangrove forests from May 2005 to August 2006. The species are distributed among 9 families and 24 genera. Fifteen species are new records from mangrove forests of the world and eight species are recorded for the first time from the State of Santa Catarina. The complete checklist is available on <http://www.mycotaxon.com/resources/weblists.html>.

Key words — Neotropics, fungal taxonomy, white-rot fungi

Introduction

Close to 35% of mangrove forests, one of the world's threatened major tropical ecosystems, have been lost in the last twenty years (Valiela et al. 2001). These ecosystems occur worldwide on sheltered shores, mainly in the tropics, and their distribution is closely related to basic features of the marine environment, mainly salinity (Chapman 1977).

Plant diversity is low in mangrove forests (Alongi 2002, Lana 2004), with about 70 species of trees and shrubs known from all over the world (Duke 1992). New World mangrove forests are composed of nine tree species representing *Avicennia* (4 spp.), *Rhizophora* (3 spp.), *Laguncularia* (1 sp.), and *Conocarpus* (1 sp.) (Cintrón & Schaeffer-Novelli 1980).

Along the South American Atlantic coast, the austral limit of mangroves is at the city of Laguna, Brazil, located at latitude of 28°55' S, in the State of Santa Catarina (Cintrón & Schaeffer-Novelli 1980). These ecosystems are well represented in Brazil, which includes one of the six largest mangrove forests in the world (Lacerda 1984).

Mangrove species diversity is well known for animals and plants but poorly known for other organisms such as fungi (Macintosh & Ashton 2002). Most mangrove fungi refer mainly to 'marine fungi', which grow and sporulate exclusively in marine or estuarine habitats (Kohlmeyer & Kohlmeyer 1979). Little is known about terrestrial fungi in mangrove forests (Hyde & Lee 1995).

Previous studies on Santa Catarina Island mangroves have revealed interesting data on myxomycetes and fungi taxonomy (Trierveiler-Pereira et al. 2008a, b; Baltazar et al. 2009b).

Of the 112 total xylophilous basidiomycetes recorded from mangrove forests around the world (Baltazar et al. 2009a), Brazilian mangroves are the best known primarily due to the research of Campos et al. (2003) and Sotão et al. (1991, 2002, 2003). The present study is the first basidiomycete survey carried out in southern Brazil mangrove forests.

Materials and methods

Santa Catarina Island is located in the central-east of the State of Santa Catarina (27°35' S and 48°32' W) in the Florianópolis municipality. Mangroves are found only on the western shores of the island, where there are low-energy (i.e. little wave action) sites. The four largest mangroves on the island are: Ratoes (29°30'00" S, 48°27'00" W), Saco Grande (28°37'30" S, 48°27'30" W), Itacorubi (27°34'14" S, 48°30'07" W) and Rio Tavares (27°38'40" S, 48°30'17" W). The mangrove tree species from these areas are *Avicennia schaueriana* Stapf & Leechm. ex Moldenke, *Laguncularia racemosa* C.F. Gaertn. and *Rhizophora mangle* L. The most common species is *A. schaueriana*, also known as black-mangrove or "siriúba" (Souza-Sobrinho et al. 1969).

During 26 field trips to the Santa Catarina Island mangroves, from May 2005 to August 2006, 265 xylophilous basidiomycete specimens were collected. Whenever possible, the host species was identified. Microscopic characters were examined and measured using light microscopy, in mounts of 1% aqueous phloxine solution (plus 1% or 5% KOH) and Melzer's reagent (Ryvarden 1991). Drawings were made with the aid of a camera lucida. Vouchers are preserved in Herbarium FLOR (Holmgren & Holmgren 1998).

Results

Thirty-three xylophilous basidiomycete species representing nine families were identified in the surveyed areas. Most species were recorded from dead wood; however, four species [*Fuscoporia gilva* (Schwein.) T. Wagner & M. Fisch., *Cerocorticium molle* (Berk. & M.A. Curtis) Jülich, *Cymatoderma dendriticum* (Pers.) D.A. Reid, *Schizophyllum commune* Fr.] were also collected from living trees. *Avicennia schaueriana*, with twenty-three recorded species, was the most

common host. *Phellinus allardii* (Bres.) S. Ahmad and *Perenniporia ohienensis* (Berk.) Ryvarden were only collected on *Laguncularia racemosa*, whereas *Hexagonia hydroides* (Sw.) M. Fidalgo was collected on *Rhizophora mangle*. *Fuscoporia gilva*, *Cerocorticium molle*, *Pycnoporus sanguineus* (L.) Murrill, and *Schizopora paradoxa* (Schr.) Donk were gathered on all three host trees.

In this survey, the Itacorubi mangrove forest had the highest species diversity with twenty-five species. Seven species [*Auricularia fuscosuccinea* (Mont.) Henn., *Cerocorticium molle*, *Pycnoporus sanguineus*, *Trametes elegans* (Spreng.) Fr., *T. villosa* (Sw.) Kreisel, *Schizophyllum commune*, *Schizopora paradoxa*] were found in all four mangrove forests. Most of the identified species have a cosmopolitan or pantropical (both with 14 spp.; 42.4%) distribution, and five species (15.15%) are neotropical.

The complete checklist of the xylophilous basidiomycetes in Santa Catarina Island mangroves is available on <http://www.mycotaxon.com/resources/weblists.html>.

Conclusions

In their comprehensive study, Baltazar et al. (2009a) reported 112 xylophilous basidiomycetes species from mangrove forests. This study adds 15 species (13.4%) to that list for a total of 127 species. In addition, four species are recorded for the first time from Brazilian mangrove forests. Furthermore, we add 8 new records to the basidiomycete mycota in the State of Santa Catarina, which has been studied for twenty years with 157 recorded species (Drechsler-Santos et al. 2008).

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Literature cited

- Alongi DM. 2002. Present state and the future of the world's mangroves forests. *Environmental Conservation* 29(3): 331–349.
- Baltazar JM, Trierveiler-Pereira L, Loguercio-Leite C. 2009a. A checklist of xylophilous basidiomycetes (*Basidiomycota*) in mangroves. *Mycotaxon* 107: 221–224.
- Baltazar JM, Trierveiler-Pereira L, Loguercio-Leite C, Ryvarden L. 2009b. Santa Catarina Island mangroves 3 – A new species of *Fuscoporia*. *Mycologia* (in press).
- Campos EL, Sotão HMP, Cavalcanti MAQ, Luz AB. 2003. *Basidiomycetes* de manguezais da APA de Algodoal-Maiandeuá, Pará, Brasil. *Bol. Mus. Para. Emílio Goeldi, sér. Ciências Naturais* 1(1): 97–102.

- Chapman VJ. 1977. Introduction. In: Chapman VJ (ed.). Wet coastal ecosystems. Oxford: Elsevier.
- Cintrón G, Schaeffer-Novelli Y. 1980. Introducción a la ecología del manglar. San Juan: Departament of Natural Resources and São Paulo: Instituto Oceanográfico, USP.
- Drechsler-Santos ER, Groposo C, Loguercio-Leite C. 2008. Additions to the knowledge of lignocellulolytic basidiomycetes in forests from Santa Catarina, Southern Brazil. *Mycotaxon* 103: 197–200.
- Duke NC. 1992. Mangrove Floristics and Biogeography. In: Robertson AI, Alongi DM. (eds.). Tropical Mangrove ecosystems. Washington: American Geophysical Union.
- Holmgren PK, Holmgren NH. 1998 [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>
- Hyde KD, Lee SY. 1995. Ecology of mangrove fungi and their role in nutrient cycle: what gaps occur in our knowledge? *Hydrobiologia* 295: 107–118.
- Kohlmeyer J, Kohlmeyer E. 1979. Marine mycology: the higher fungi. New York: Academic Press.
- Lacerda LD. 1984. Manguezais: florestas de beira-mar. *Ciência Hoje* 3(13): 62–70.
- Lana PC. 2004. Novas formas de gestão dos manguezais brasileiros: a Baía de Paranaguá como estudo de caso. *Desenvolvimento e Meio Ambiente* 10: 169–174.
- Macintosh DJ, Ashton EC. 2002. Review of mangrove biodiversity conservation and management. Final Report, University of Aarhus, Denmark.
- Ryvarden L. 1991. Genera of polypores. Nomenclature and taxonomy. *Syn. Fungorum* 5: 1–363.
- Sotão HMP, Bononi VLR, Figueiredo TS. 1991. Basidiomycetes de manguezais da Ilha de Maracá, Amapá, Brasil. *Bol. Mus. Para. Emílio Goeldi, ser. Bot.* 7(1): 109–114.
- Sotão HMP, Campos EL, Costa SPSE, Melo OA, Azevedo JC. 2002. Basidiomycetes macroscópicos de manguezais de Bragança, Pará, Brasil. *Hoehnea* 29(3): 215–224.
- Sotão HMP, Campos EL, Gugliotta AM, Costa SPSE. 2003. Fungos macroscópicos: Basidiomycetes. In MEB Fernandes (org). *Os manguezais da costa norte brasileira*. Maranhão: Fundação Rio Bracanga.
- Souza-Sobrinho RJ, Bresolin A, Klein RM. 1969. Os manguezais da Ilha de Santa Catarina. *Insula* (2): 1–21.
- Trierveiler-Pereira L, Baltazar JM, Loguercio-Leite C. 2008a. Santa Catarina Island mangroves 1 – First report of *Myxomycetes* on *Avicennia schaueriana*. *Mycotaxon* 103: 145–152.
- Trierveiler-Pereira L, Baltazar JM, Loguercio-Leite C. 2008b. Santa Catarina Island mangroves 2 – First report of *Cytospora rhizophorae* from Brazil. *Mycotaxon* 104: 119–122.
- Valiela I, Bowen JL, York JK. 2001. Mangrove forests: one of the world's threatened major tropical environments. *BioScience* 51(10): 807–815.

How many species in the *Rhizopogon roseolus* group?

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Abstract —Species concepts in the *Rhizopogon roseolus* species group (*Boletales*, *Basidiomycotina*) are analyzed using nrDNA ITS sequence data. This group includes taxa traditionally placed in sect. *Rhizopogon* in subsect. *Rhizopogon* (stirps *Rubescens*) and subsect. *Angustipori* (stirps *Vulgaris*) along with many other European species. ITS sequence analyses separate the collections into numerous clades and imply the existence of five phylogenetic species.

Key words — internal transcribed spacer, nrDNA, taxonomy

Introduction

The genus *Rhizopogon* belongs to the order *Boletales* and comprises ca 100 species. Martín (1996) reported 21 species of *Rhizopogon* for Europe with *R. roseolus* (Corda) Th. Fr. sensu M.P. Martín cited as the most abundant. However, the taxonomy of *R. roseolus* has long been controversial (Smith & Zeller 1966, Groß & Schmitt 1974) and current authors (Martín 1996, Grubisha et al. 2002) also disagree over its species concept.

The holotype of *R. roseolus* — an illustration by Corda (1831) of *Splanchnomyces roseolus* — shows basidiomes with a uniformly vinaceous peridium and white gleba. In the genus *Rhizopogon*, the peridium and gleba colour serve with chemical tests as the main characters used to describe new species. The absence of yellow in the Corda illustration caused many authors to describe new taxa. However, recent morphological analyses by Martín (1996) proposed that 36 taxa described by many different authors (Corda 1854; Boudier 1885; Karsten 1886, 1889; Fries 1909; Velenovský 1931, 1939; Vacek 1948; Soehner 1956; Svrček 1958; Smith & Zeller 1966; Pacioni 1984a,b) are synonymous with *R. roseolus*.

Smith & Zeller (1966) included some of these taxa in *Rhizopogon* subgen. *Rhizopogon* sect. *Rhizopogon* but in two different subsections and stirps

according mainly to spore size: a) subsect. *Rhizopogon*, stirps *Rubescens* with basidiospores $\geq 3 \mu\text{m}$ diam — e.g. *R. abietis* A.H. Sm., *R. luteorubescens* A.H. Sm., *R. pseudoroseolus* A.H. Sm., *R. roseolus* sensu A.H. Sm., *R. ventricisporus* A.H. Sm., and four *R. rubescens* varieties); and b) subsect. *Angustipori*, stirps *Vulgaris* with spores $\leq 3 \mu\text{m}$ diam — e.g. *R. vulgaris* (Vittad.) M. Lange.

Other authors, such as Groß & Schmitt (1974), separated taxa according to spore volume ($V_m = 0.5 \times w^2 \times L$ (w = spore weight, L = spore length)). Thus, Groß et al. (1980) placed the following in the *R. roseolus* complex based on spore volume: A—*R. vulgaris* ($V \approx 15 \mu\text{m}^3$); B—“*R. vulgaris* var. *intermedius*” Svrček and *R. pumilionus* (Ade) Bataille ($V \approx 30 \mu\text{m}^3$); C—*R. luteorubescens* ($V \approx 45 \mu\text{m}^3$); D—*R. rubescens* (Tul. & C. Tul.) Tul. & C. Tul. var. *rubescens* sensu A.H. Sm. as synonymous of *R. roseolus*, ($V \approx 60 \mu\text{m}^3$); and E—*R. hymenogastrosporus* Soehner (with two types of basidiospores, the larger with a $V \approx 240\text{--}280 \mu\text{m}^3$).

In earlier preliminary molecular analyses (nrDNA ITS2 sequence cladistic analyses; cluster analysis of ITS-RFLP patterns produced using 5 endonucleases), Johansson & Martín (1999) and Martín et al. (2000) found that *R. roseolus* DNA isolates show a high degree of variability even when obtained from basidiomes comprising the same collection. Furthermore, the different patterns obtained did not correlate to the different taxa proposed by Smith & Zeller (1966) or Groß et al. (1980).

Based on morphological and ITS sequences, Grubisha et al. (2002) presented a *Rhizopogon* subgeneric taxonomic revision. In agreement with Johansson & Martín (1999), they concluded that Smith & Zeller (1966) sect. *Rhizopogon* is not monophyletic and proposed 5 subgenera to accommodate Smith & Zeller (1966) sections, subsections, and stirps. However, Grubisha et al (2002) included only 10 taxa of Smith & Zeller's sect. *Rhizopogon*. The phylogenetic tree placed one *R. roseolus* (subsect. *Rhizopogon*, stirps *Rubescens*) collection, two *R. vulgaris* (subsect. *Angustipori*, stirps *Vulgaris*) collections, and one *R. burlinghamii* A.H. Sm. (subsect. *Angustipori*, stirps *Ochraceorubens*) collection together in one clade; Grubisha et al (2002) described this clade as subgen. *Roseoli*.

In recent years, ITS sequence-based analyses have proved very useful for re-addressing species concepts in *Rhizopogon* (Kretzer et al. 2003) and in revealing cryptic species in other *Boletales* taxa, such as *Pisolithus* (Martín et al. 2002) and *Coniophora puteana* (Hauserud et al. 2006).

Thus, the main objectives of our paper using phylogenetic analyses of ITS DNA sequences are:

1. To explore the molecular variability of *R. roseolus* sensu M.P. Martín by comparing taxa regarded as synonymous in Martín (1996) and correlating the variability with morphological, ecological, or geographical differences.

2. To clarify how closely related are the taxa referred by Smith & Zeller (1966) to *Rhizopogon*, sect. *Rhizopogon*, subsects. *Rhizopogon* (stirps *Rubescens*) and *Angustipori* (stirps *Vulgaris*).

Materials and methods

Material

This study is based on 1458 collections previously identified as *R. roseolus* (Martín 1996) and new collections found in the MA herbarium (RJB). APPENDIX 1, lists collections selected for sequencing. Many collections were previously proposed as synonymous to *R. roseolus* in Martín (1996): *R. duriusculus* Velen., *R. gigasporus* Pacioni, *R. graveolens* f. *pomaceus* Vacek, *R. inodorus* Velen., *R. lapponicus* P. Karst., *R. minor* Velen., *R. luteo-rubescens*, *R. mohelnensis* Velen., *R. pseudoroseolus*, *R. pumilionus*, *R. roseolus* f. *amygdaloporus* Th. Fr., *R. roseolus* f. *aberrans* Th. Fr., *R. roseolus* var. *foetens* Svrček, *R. rubescens*, *R. rubescens* var. *ochraceus* A.H. Sm., *R. rubescens* var. *pallidimaculatus* A.H. Sm., *R. sardous* Pacioni, *R. tenuisporus* Velen., “*R. tenuisporus* var. *intermedius*”, *R. ventricisporus*, and *R. vulgaris*.

Other representatives of sect. *Rhizopogon* (*R. abietis*, *R. luteolus* Fr., *R. ochraceorubens* A.H. Sm., *R. ochroleucoides* A.H. Sm.) were included, with taxa from other *Rhizopogon* sections selected as outgroups — sect. *Amylopogon* (*R. atrovioleaceus* A.H. Sm., *R. ellenae* A.H. Sm.), sect. *Fulviglebae* (*R. diabolicus* A.H. Sm., *R. ochraceisporus* A.H. Sm., *R. vinicolor* A.H. Sm.), and sect. *Villosuli* (*R. colossus* A.H. Sm., *R. fragrans* A.H. Sm., *R. hawkeriae* A.H. Sm.).

TABLE 1 sets forth the classification of the taxa listed in APPENDIX 1 according to Smith & Zeller (1966) and Grubisha et al. (2002). Many taxa are not included in TABLE 1, since neither Smith & Zeller (1966) nor Grubisha et al. (2002) studied the specimens.

Morphological characters

New collections were identified according to morphological criteria following Martín (1996). Spore volumes were calculated (Groß & Schmitt 1974) for collections representing the *Rhizopogon roseolus* group (TABLE 2), with volumes calculated for each specimen in collections with more than one basidiome (e.g. 3ROS to 11ROS).

Molecular taxonomic methods

Genomic DNA was extracted using an E.Z.N.A. Fungi DNA miniprep kit (Omega Biotek, Doraville, USA) as described in Martín & García-Figueres (1999). DNA fragments containing internal transcribed spacers ITS1 and ITS2 were amplified with direct universal primers ITS1F or ITS1 and the reverse primer ITS4 as described in Martín & Raidl (2002). Prior to sequencing, the amplification products were cleaned using QIAquick gel PCR purification kit (QIAGEN, Valencia, California, USA). When more than 20 ng/μl were obtained, both strands were sequenced separately using primers mentioned above at Secugen S.L. (Madrid, Spain). However, when weak products were visualized on agarose gels, the products were cloned using pGEM®-T Easy Vector System II cloning kit (Promega Corporation, Madison, Wisconsin, USA). From each cloning reaction 3 clones were selected for sequencing. To confirm that the

TABLE 1. Comparison of Smith & Zeller (1966) and Grubisha et al. (2002) classification of taxa included in this study.

SMITH & ZELLER (1966)			TAXA	GRUBISHA ET AL. (2002)*
Sect. <i>Amylopogon</i>			<i>R. atroviolaceus</i>	n.d.
			<i>R. ellenae</i>	Subgen. <i>Amylopogon</i>
Sect. <i>Fulviglebae</i>			<i>R. diabolicus</i>	Subgen. <i>Villosuli</i> sect. <i>Vinicolores</i>
			<i>R. ochraceisporus</i>	
			<i>R. vinicolor</i>	
Sect. <i>Villosuli</i>			<i>R. colossus</i>	Subgen. <i>Villosuli</i> sect. <i>Villosuli</i>
			<i>R. hawkeræ</i>	
			<i>R. fragrans</i>	n.d.
SECT.	SUBSECT.	STIRPS		
<i>Rhizopogon</i>	<i>Angustipori</i>	<i>Ochraceorubens</i>	<i>R. ochraceorubens</i>	Subgen. <i>Rhizopogon</i>
		<i>Vulgaris</i>	<i>R. vulgaris</i>	Subgen. <i>Roseoli</i>
	<i>Rhizopogon</i>	<i>Luteolus</i>	<i>R. luteolus</i>	Subgen. <i>Rhizopogon</i>
		<i>Rubescens</i>	<i>R. abietis</i>	n.d.
			<i>R. luteorubescens</i>	
			<i>R. ochroleuroides</i>	
			<i>R. pseudoroseolus</i>	
			<i>R. roseolus</i>	Subgen. <i>Roseoli</i>
			<i>R. rubescens</i> var. <i>rubescens</i> <i>R. rubescens</i> var. <i>ochraceus</i> <i>R. rubescens</i> var. <i>pallidimaculatus</i> <i>R. ventricisporus</i>	n.d.

*Taxa not included in Grubisha et al. (2002) are indicated as n.d. (no data).

inserted product was correct, prior to sequencing, 2 µl of the purified plasmid DNA was digested with EcoRI according to manufacturer instructions. Both strands were sequenced separately using vector specific primers T7 and SP6 at Secugen S.L. Sequencher (Gene Codes Corporations, Ann Arbor, Michigan, USA) was used to identify the consensus sequence from the two strands of each ITS nrDNA isolate. Blastn searches with megablast option were used to compare the sequences obtained against the sequences in the National Center of Biotechnology Information (NCBI) nucleotide databases. New consensus sequences have been lodged in the EMLB-EBI database with the accession numbers indicated in APPENDIX 1.

SEQAPP software for multiple sequences was used to search for the best alignment. Two alignments were created. Alignment 1 included sequences obtained from taxa cited in APPENDIX 1. Alignment 2, generated after analyzing the first alignment, included only

sequences grouped in the *R. roseolus* complex clade and selected sister group sequences. Where alignment ambiguities, the alignment chosen was the one generating the fewest potentially informative characters. Alignment gaps were marked as “–”, unresolved nucleotides and unknown sequences were indicated with “N”. Alignment were analysed using PAUP*Version 4.0b10 for Macintosh (Swofford 2003) and MrBAYES 3.0 7 (Huelsenbeck & Ronquist 2001).

Maximum parsimony analyses (MP) were inferred using the heuristic search option in PAUP*4.0b10. Gaps were treated as missing data. Branch lengths equal to zero were collapsed to polytomies. Nonparametric bootstrap (bs) support (Felsenstein 1985) for each clade was tested based on 10.000 replicates, using the fast-step option. The consistency index CI (Kluge & Farris 1969), retention index RI (Farris 1989), and rescaled consistency index RC (Farris 1989) were obtained. Four alignment analyses were performed (TABLE 3): 1) alignment of all obtained sequences (both complete and incomplete) and all characters, including ambiguities; 2) alignment of all obtained sequences (both complete and incomplete) but excluding the part of the alignment with ambiguities; 3) alignment of only complete sequences and excluding ambiguities, 4) alignment of only complete sequences but without excluding ambiguities. In Alignment 2, incomplete sequences were eliminated and no ambiguities were obtained, so only one analysis was done.

Bayesian analyses of the two alignments (all taxa and all characters) were done separately using MrBAYES 3.0 (Huelsenbeck & Ronquist 2001) following Huelsenbeck et al. (2000) and Larget & Simon (1999). Posterior probabilities (pp) were approximated by sampling trees using a Markov Chain Monte Carlo (MCMC) method. Posterior probabilities of each branch were calculated by counting the frequency of trees that were visited during the course of the MCMC analysis. The analysis was performed assuming the general time reversible model (Rodríguez et al. 1990) including estimation of invariant sites and assuming a discrete gamma distribution with six categories (GTR+I+G). No molecular clock was assumed. A run with 2,000,000 generations starting with a random tree and employing 12 simultaneous chains was executed. Every 100th tree was saved into a file for a total of 20,000 trees. We plotted the log-likelihood scores of sample points against generation time using TRACER 1.0 (<http://evolve.zoo.ox.ac.uk/software.html?I=tracer>) and determined that stationarity was achieved when the log-likelihood values of the sample point reached a stable equilibrium value (Huelsenbeck & Ronquist 2001). The initial 1,000 trees were discarded as burn-in before stationarity was reached. Using the MrBAYES “sumt” command, majority-rule consensus trees were calculated from 19,000 trees sampled after reaching likelihood convergence to calculate the posterior probabilities of the tree nodes. Phylogenetic trees were drawn using TreeView (Page 1996).

Only supported (bs>0.85 and/or pp> 0.95) monophyletic terminal clades were considered for determining a phylogenetic species.

Results

From some samples (*R. abietis*, *R. inodorus*, *R. lapponicus*, *R. minor*, *R. ochroleuroides*, *R. pumilionus*, *R. roseolus* f. *aberrans*, *R. rubescens* var. *ochraceus*, “*R. tenuisporus* var. *intermedius*”, *R. ventricisporus*) it was not

TABLE 2. Possible host and spore volume of taxa under the *Rhizopogon roseolus* complex clade (FIGS. 1–2).

TAXON ¹	CODE	POSSIBLE HOST ¹	SPORE VOLUME ²
<i>R. gigasporus</i>	1GIG	<i>P. pinaster</i>	E
<i>R. graveolens</i> f. <i>pomaceus</i>	1POM	<i>Pinus</i> spp.	B
<i>R. luteorubescens</i>	1LRU	<i>P. contorta</i>	C
<i>R. minor</i>	1MIN	<i>Carpinus</i> sp.	B
<i>R. mohelnensis</i>	1MOH	<i>Abies</i> sp., <i>P. sylvestris</i>	D
<i>R. pseudoroseolus</i>	1PSE	<i>P. resinosa</i>	C
	2PSE	<i>P. resinosa</i>	C
	3PSE	<i>P. resinosa</i>	C
<i>R. roseolus</i>	1ROS	<i>Pinus</i> spp.	n.d.
	2ROS	<i>P. contorta</i>	B
	3ROS–11ROS	<i>Pi. abies</i>	C, –, D, B, C, B, B, C, B
	12ROS	<i>Abies alba</i>	D
	13ROS	<i>Ca. sativa</i> , <i>P. pinaster</i> , <i>Q. pyrenaica</i>	B
	14ROS	<i>P. sylvestris</i>	D
	15ROS	under <i>Cistus</i> sp.	C
	16ROS	<i>P. nigra</i> / <i>F. sylvatica</i>	D
	18ROS	<i>P. sylvestris</i>	D
	19ROS–20ROS	<i>P. sylvestris</i>	C, C
	21ROS–22ROS	<i>P. sylvestris</i>	D, B
	23ROS–28ROS	<i>P. sylvestris</i>	C, B, C, B, C, B
	29ROS	<i>P. sylvestris</i>	D
	30ROS–31ROS	<i>P. sylvestris</i> , <i>P. nigra</i>	B, B
	32ROS–35ROS	<i>P. sylvestris</i> , <i>P. nigra</i>	A, B, A, B
	36ROS	Pine forest under <i>Q. ilex</i>	C
	37ROS	<i>P. sylvestris</i>	D
	38ROS	<i>P. pinaster</i>	C
	39ROS	<i>P. pinaster</i>	B
	40ROS	<i>P. pinaster</i> , <i>Q. ilex</i>	B
	41ROS	<i>P. sylvestris</i> , <i>Picea</i> sp., <i>Larix</i> sp.	D
	42ROS	<i>Pinus</i> sp.	n.d.
	43ROS	<i>P. sylvestris</i>	n.d.
	44ROS	<i>P. sylvestris</i> , <i>Q. robur</i> , <i>Co. avellana</i>	n.d.
<i>R. rubescens</i>	1RUB	<i>P. muricata</i>	n.d.
	3RUB	<i>P. sylvestris</i>	C
	4RUB	<i>P. sylvestris</i>	n.d.
	5RUB	<i>P. sylvestris</i>	n.d.
<i>R. rubescens</i> var. <i>pallidimaculatus</i>	1PAL	<i>Abies</i> sp., <i>Pinus</i> sp.	B
<i>R. sardous</i>	1SAR	Mixed forest: <i>Pinus</i> sp., <i>Eucalyptus</i> sp.	B
<i>R. vulgaris</i>	1VUL	<i>Pinus</i> sp.	n.d.
	2VUL	<i>Pinus</i> sp.	n.d.

1. Abbreviations: *Ca.* = *Castanea*; *Co.* = *Corylus*; *F.* = *Fagus*; *Pi.* = *Picea*; *P.* = *Pinus*; *Q.* = *Quercus*.
2. In sample 4ROS almost all spores lacking an exosporium; n.d. = size data lacking.

possible to get good sequences, even after cloning. In others (*R. duriusculus*, *R. graveolens* f. *pomaceus*, *R. roseolus* var. *foetens* and *R. tenuisporus*), the sequences obtained were so different from the rest of *Rhizopogon* that was not possible to include them in the alignment; the Blast search gave a very high score to sequences of *Boletus* sp. and/or *Coniophora puteana* (Schumach.) P. Karst.; in APPENDIX 1, this is indicated with a question mark.

The 50 new ITS sequences obtained in this study are listed (with GenBank accession numbers) in Appendix 1. Eleven sequences were derived from type material. The sequences were aligned and analyzed together with 28 other taxa representing sect. *Rhizopogon* subsects. *Rhizopogon* (stirps *Rubescens* & *Luteolus*) and *Angustispori* (stirps *Vulgaris* & *Ochraceorubens*), sect. *Villosuli*, sect. *Fulviglebae*, and sect. *Amylopogon* obtained in previous studies (Johanesson & Martín 1999, Martín & Raidl 2002) or by other authors (Taylor & Bruns 1999, Grubisha et al. 2002, Kretzer et al. 2003, Menkis et al. 2005, Tedersoo et al. 2006, Fransson et al. 2007).

Alignment 1

The complete ITS dataset included 69 sequences and 840 characters (Alignment 1). The values of the 4 parsimony analyses are summarized in TABLE 3. In the B/MCMC analysis of the combined data set, the likelihood parameters in the sample had the following mean (Variance): LnL = -3449,377 (0.053), base frequencies $\pi(A) = 0.254$ (0.0003), $\pi(C) = 0.205$ (0.0004), $\pi(G) = 0.232$ (0.0003), $\pi(T) = 0.309$ (0.0003), rate matrix $r(AC) = 2.048$ (0.003), $r(AG) = 4.551$ (0.003), $r(AT) = 2.72$ (0.003), $r(CG) = 1.391$ (0.004), $r(CT) = 7.104$ (0.002), $r(GT) = 1$, the gamma shape parameter $\alpha = 0.109$ (0.002), and the proportion of invariable site $p(\text{invar}) = 0.338$ (0.0003).

The topologies of the four MP analyses were similar to each other (not shown), and also to the B/MCMC tree (FIG. 1).

Rhizopogon luteolus (Smith & Zeller 1966: sect. *Rhizopogon*, stirps *Luteolus*) and *R. ochraceorubens* (Smith & Zeller 1966: Sect. *Rhizopogon*, stirps *Ochraceorubens*), both from subgen. *Rhizopogon*, were basal to the other *Rhizopogon* taxa studied.

One *R. rubescens* collection (2RUB, distributed as Ellis North Amer. 943 Exsiccati and described as *R. rubescens* sensu A.H. Sm.) was basal to the well-supported clade (99% bs/1.00 pp) that comprised collections of subgen. *Amylopogon* and subgen. *Villosuli* as well as the remaining taxa studied.

The *R. roseolus* complex clade (subgen. *Roseoli* in Grubisha et al. 2002) was sister (75% bs/1.0 pp) to the highly supported (93% bs/1.0 pp) clade formed by 6 taxa from subgen. *Villosuli* (3 from sect. *Villosuli* and 3 from *Fulviglebae* in Smith & Zeller, 1966). However, the sister-group relationship was not well supported (63% bp /0.68 pp).

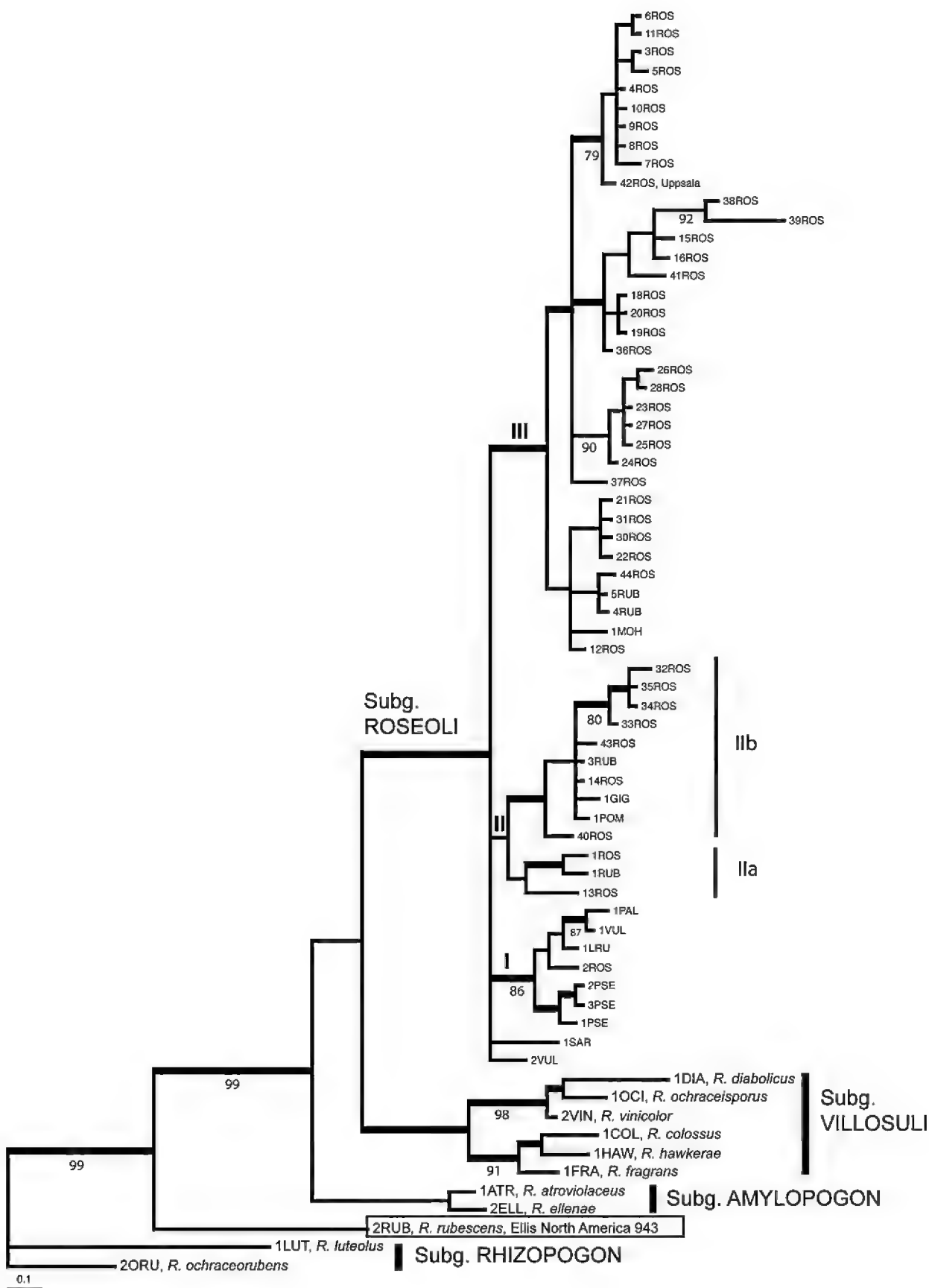


FIG. 1. Majority rule consensus tree from Bayesian analysis of *Rhizopogon* taxa cited in Appendix 1 (Alignment 1). Branches with posterior probabilities superior to 90 are indicated in bold. Bootstrap values superior to 50% are indicated under the branches. The analysis separated collections of *Rhizopogon* subgen. *Roseoli* into at least five clades.

TABLE 3. Maximum parsimony analyses of the *Rhizopogon roseolus* group.

	ANALYSIS 1 ^a	ANALYSIS 2 ^b	ANALYSIS 3 ^c	ANALYSIS 4 ^d
Total characters	840	740	740	840
Constant characters	624	542	547	629
Parsimony-uninformative characters	98	84	85	99
Parsimony-informative characters	118	114	108	112
Tree length	347	325	306	328
Consistency index (CI)	0.7579	0.7477	0.7647	0.7744
Homoplasy index (HI)	0.2421	0.2523	0.2353	0.2256
Rescaled Index (RI)	0.8791	0.8794	0.8837	0.8833
Rescaled consistency index (RC)	0.6663	0.657	0.6758	0.6840

^a all sequences and characters included
^b all sequences included; ambiguous characters excluded
^c only complete sequences included; ambiguous characters excluded
^d only complete sequences included; ambiguous characters included

The *R. roseolus* complex collections fell into three main clades (I, II, III). Clade II was not well supported, however, and the relationship of one *R. sardous* collection and one *R. vulgaris* collection (2VUL from US) to the other *R. roseolus* complex collections included in the clade was not resolved.

Clade I contained seven sequences obtained from US samples collected under *Pinus* spp. (TABLE 2): *R. roseolus* sensu AH. Sm. (2ROS), *R. pseudoroseolus* (1PSE-3PSE), *R. luteorubescens* (1LRU) and one sequence of *R. vulgaris* (1VUL). The sequence produced from a sample of *R. rubescens* var. *pallidimaculatus* (1PAL) collected under *Abies* sp. clustered in this clade. Only two spore volume ranges were obtained (B and C).

Clade II was not well supported (0.61 pp) and was composed of two subgroups. Clade IIa included two sequences from California (US), identified as *R. roseolus* (1ROS) and *R. rubescens* (1RUB), and a sample from Spain (13ROS) collected under *Castanea sativa* Mill. in a mixed forest of *Pinus pinaster* Aiton and *Quercus pyrenaica* Willd. Clade IIb was represented by samples (14ROS, 32ROS-34ROS, 40ROS) collected under *Pinus sylvestris* L. in Spain, a possible *R. rubescens* (3RUB) collected close to a *R. roseolus* (14ROS) and two type collection sequences (*R. graveolens* f. *pomaceus*, 1POM; *R. gigasporus*, 1GIG, newly described from Italy in 1984 and with abnormally large spores).

Clade III contained European *R. roseolus* samples from Slovenia (3ROS-9ROS) collected under *Picea abies* (L.) H. Karst., samples from Italy under *Pinus pinaster* (38ROS-39ROS) and *P. nigra* J.F. Arnold (16ROS), many Spanish samples collected under *P. sylvestris*, and two samples collected under *Abies*

alba Mill. (one obtained from the *R. mohelnensis* type collection). Moreover, two sequences obtained from ectomycorrhizal root tips and identified as *R. rubescens* (4RUB and 5RUB) clustered in this group. Spore volumes ranged from $\sim 30 \mu\text{m}^3$ (A, 12 collections) through $\sim 45 \mu\text{m}^3$ (B, 10 collections), and $\leq 60 \mu\text{m}^3$ (C, 8 collections). No other spore volume data were obtained, although collapsed spores lacking an exosporium were found in collection 4ROS.

Alignment 2

In order to improve the resolution and refine alignment in the *R. roseolus* complex clade (Subg. *Rhizopogon*), the following sequences were excluded — *R. ochraceorubens* (2ORU), *R. luteolus* (1LUT), Ellis North Amer. 943 Exsiccati (2RUB), *R. ellenae* (2ELL), *R. atroviolaceus* (1ATR), and *R. roseolus* clade collections with incomplete sequences. Here six subgen. *Villosuli* sequences were included as outgroup. The Alignment 2 complete ITS dataset included 53 sequences and 679 non-ambiguous characters among which 546 characters were constant and 92 parsimony informative. Maximum parsimony (MP) analysis under heuristic search gave 100 most parsimonious trees with a length of 214 steps, CI = 0.7430, RI = 0.9113 and RC = 0.6771.

In the B/MCMC analysis the likelihood parameters in the sample had the following mean (Variance): LnL = -2464,531 (0.009), base frequencies $\pi(\text{A}) = 0.243$ (0.0004), $\pi(\text{C}) = 0.22$ (0.0004), $\pi(\text{G}) = 0.238$ (0.0004), $\pi(\text{T}) = 0.3$ (0.0004), rate matrix $r(\text{AC}) = 0.929$ (0.003), $r(\text{AG}) = 4.857$ (0.003), $r(\text{AT}) = 1.79$ (0.004), $r(\text{CG}) = 1.796$ (0.003), $r(\text{CT}) = 5.576$ (0.003), $r(\text{GT}) = 1$, the gamma shape parameter $\alpha = 0.109$ (0.002), and the proportion of invariable site $p(\text{invar}) = 0.539$ (0.0003).

The MP and B/MCMC tree topologies were similar; only the Bayesian tree is shown in FIG 2. The specimens under *R. roseolus* complex clade (subgen. *Roseoli*) clustered in a very well supported clade (100% bs/ 1.0 pp). Alignment 1 and 2 phylogenetic analyses place sequences in almost the same main groups but show different relationships within the clades.

Again, the *R. sardous* specimen was not related to the other taxa in the *R. roseolus* complex group; however, the *R. vulgaris* collection (2VUL from US) grouped into clade I (all taxa from North America). Clade I related with two well-supported clades (IIa and III), although the relationship between them was ambiguous (< 50%/ 0.56 pp). The group formed by these clades was sister to clade IIb and the *R. sardous* specimen.

These ITS sequence analyses imply at least five possible phylogenetic “species” — *R. sardous*, clade I, clade IIa, clade IIb, and clade III. Moreover, two groups appear to have a North American affiliation (clade I and clade IIa, except isolate 13ROS from Spain), both closely related to *R. roseolus* sensu stricto (clade III).

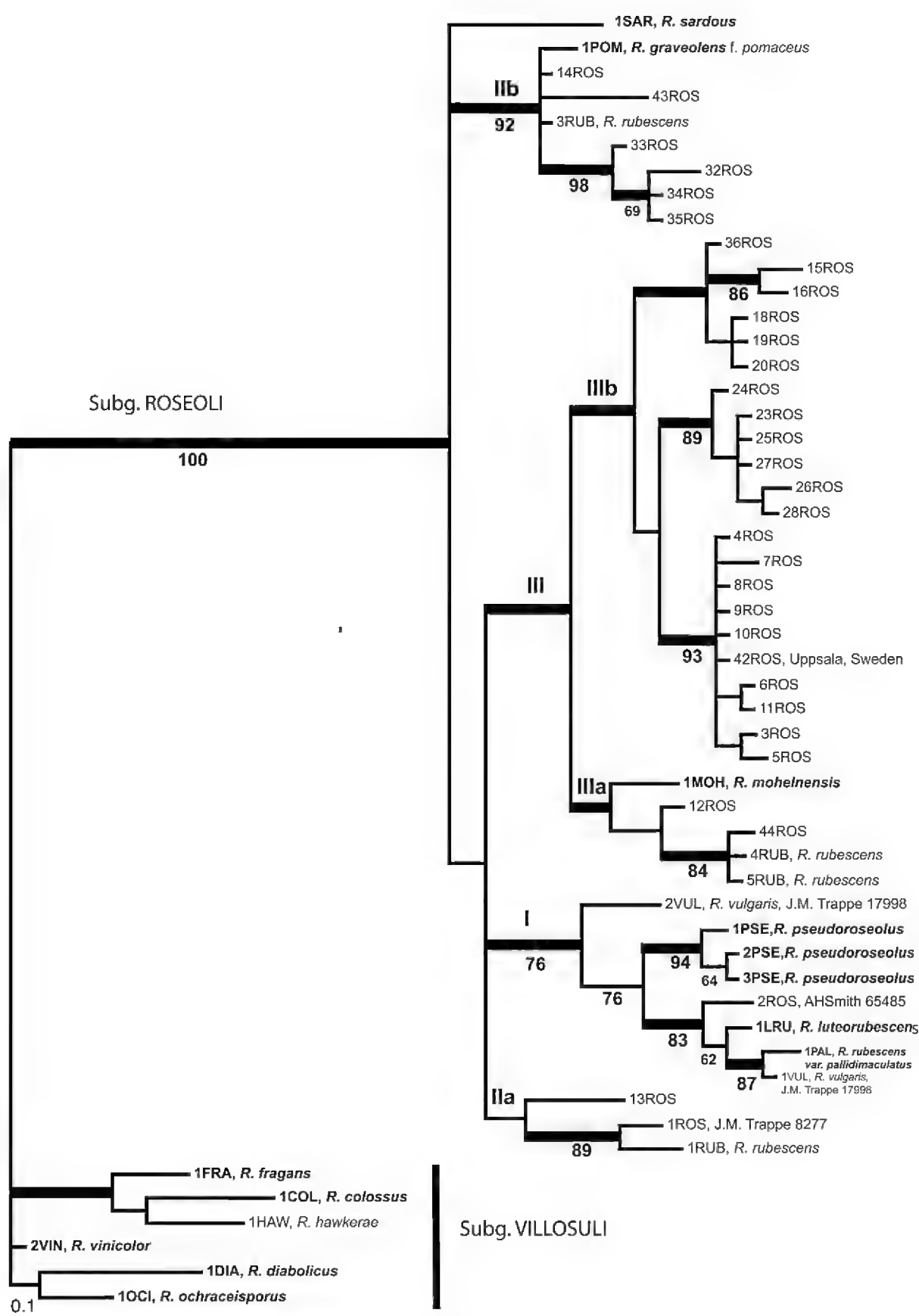


FIG. 2. Majority rule consensus tree from Bayesian analysis of *Rhizopogon* taxa cited in Appendix 1 (Alignment 2). Branches with posterior probabilities superior to 90 are indicated in bold. Bootstrap values superior to 50% are indicated under the branches. The analysis separated collections of *Rhizopogon* subgen. *Roseoli* into at least five clades.

Discussion

Molecular variability of *R. roseolus* sensu M.P. Martín

The above analyses separated collections of *R. roseolus* complex into at least five clades indicative of five possible phylogenetic species. These findings conflict taxonomically with the ~37 names proposed for this group. We note, however, that molecular data have been generated for only 11 of those 37 taxa.

Rhizopogon sardous was collected in West Sardinia beneath *Eucalyptus* and *Pinus* in sandy soil. According to Pacioni (1984b), the peridium is simple, but the external hyphae (the outer 20–80 µm) are pigmented and become pink to purple in Cresyl Blue, whereas the inner (100–120 µm) hyphae show extracellular pigments and become blue-green in Cresyl Blue. Since the Cresyl Blue reaction cannot be tested in dry specimens and no other morphological differences were observed, Martín (1996) considered *R. sardous* synonymous to *R. roseolus*. Although more fresh collections should be studied and host (*Eucalyptus* or *Pinus*) specificity level should be tested, our molecular data strongly support *R. sardous* as a distinctive species. As mentioned in the Kjølner & Bruns (2003) study on *Rhizopogon* species in spore bank distributions across five California pine forests, isolation may drive *Rhizopogon* diversification.

CLADE I. Samples included in clade I have a North American affiliation. Three taxa — *R. luteorubescens*, *R. pseudoroseolus* and *R. rubescens* var. *pallidimaculatus* — described in Smith & Zeller (1966) cluster in this clade with a “*R. roseolus* sensu A.H. Sm.” collection. Two other collections (identified by J.M. Trappe as *R. vulgaris*) grouped with these collections; the sequence from one specimen (1VUL) is close to *R. rubescens* var. *pallidimaculatus* except for 2 base shifts (1PAL/1VUL) [alignment 1: position 7 (C/Y) and position 281 (G/A)]. A check of the “*R. vulgaris*” descriptions reveal no clear diagnostic characters except for some peridium and gleba colour variability including colour changes in those pseudotissues resulting from application of FeSO_4 and KOH. In *R. pseudoroseolus* the white gleba suggests immature basidiomes; the basidiomes described as *R. luteorubescens* appear immature, with a white, pallid yellowish to ochraceous gleba. However, the *R. rubescens* var. *pallidimaculatus* gleba colour description seems to refer to more mature basidiomes. Smith & Zeller (1966) included these taxa in subg. *Rhizopogon* sect. *Rhizopogon* subsect. *Rhizopogon* stirps *Rubescens*, where also they described *R. roseolus* sensu A.H. Sm., a taxon that does not group with any *R. roseolus* European collection. The low ITS variation within these taxa may reflect lack of resolution in this region (Bidartondo & Bruns, 2002), but our review of the macroscopical and microscopical characters implies that all these taxa could represent one distinctive North American species. Likewise, the two collections of *R. vulgaris* sensu Trappe seem to belong to this phylogenetic species. Determination of the correct name is premature,

however, until the other taxa mentioned in Smith & Zeller (1966) undergo phylogenetic analyses. Studies comparing ectomycorrhizae are also needed to clarify this group, since we have very few data related to the specific hosts. Our work, as well as that by authors before us (Martín et al. 1998, Bidartondo & Bruns 2002, Kjølner & Bruns 2003), confirms that the application of names to *Rhizopogon* collections has been very inconsistent.

CLADE IIa. This clade, which comprises only two sequences from North America and one sample from Spain (13ROS), needs additional data to improve resolution; however, we feel the clade may represent a distinctive phylogenetic species. The 1RUB sequence is derived from an unidentified ectomycorrhizal basidiome with putative suilloid morphology (isolate RCP-13 in Taylor & Bruns 1999) that molecular data place close to *R. rubescens*. Molecular analysis by Grubisha et al. (2002) supports the 1ROS sequence, obtained from a Trappe collection identified as *R. roseolus*, in a clade (87% bs) closely related to *R. burlinghamii* (subgen. *Rhizopogon* sect. *Rhizopogon* subsect. *Angustipori* stirps *Ochraceorubens*). The *R. burlinghamii* sequence located at the GenBank (AF058303) belongs to a collection from J.M. Trappe (JMT17882), not to the type collection (Zeller Herb. 8244). It is necessary to obtain the ITS sequence of the *R. burlinghamii* type collection and to compare it with the sequences in clade IIa to ascertain whether or not collections in this clade belong to the species, *R. burlinghamii*.

CLADE IIb. This clade represents European specimens associated primarily with *Pinus sylvestris* and *P. nigra*, exceptions being *R. gigasporus* (*P. pinaster*) and *R. graveolens* f. *pomaceus* (*Pinus* spp.). According to Vidal (1991), specimens of *R. roseolus* sensu stricto are associated primarily with *Pinus halepensis* Mill. and *P. sylvestris* in calcareous soils, whereas specimens of *R. rubescens* sensu stricto are found near *Pinus pinea* L. and *P. pinaster* in sandy soil. In Europe is difficult to find, at least in the Mediterranean, forests containing only one pine species. Our recent morphological revision shows that specimens in this clade have thin peridia and a high concentration of extracellular red pigments, which support these collections as belonging to *R. rubescens* sensu stricto. Thus *R. gigasporus* and *R. graveolens* f. *pomaceus* are confirmed as synonyms of *R. rubescens*.

CLADE III. Sequences obtained from specimens from Slovenia, Lithuania, Portugal, Spain, and Sweden are included in this clade. Based on our sampling, clade III could correspond to *R. roseolus* sensu stricto. Corda's original description of *Splanchnomyces roseolus* was based on specimens collected from Praha (Czech Republic) under *Pinus sylvestris*. In this clade, only the sequence of *R. mohelnensis* (1MOH), collected in Czech Republic under *Pinus sylvestris* was included, which should be regarded as a synonym of *R. roseolus* sensu stricto. When immature, in *R. roseolus* the peridium is pure white, then yellow

to pink; rubbing turns the peridium red to deep purple. Although many of the collections fruited under *Pinus sylvestris*, other possible hosts (*P. nigra*, *P. pinaster* and *Picea abies*) are mentioned in the herbarium labels.

We found that in Menkis et al. (2005) the sequences were not well identified, since the strain NA202A (43ROS) belongs to the *R. rubescens* clade and strains “aurim738” (4RUB) and “aurim NS182” (5RUB) belong to *R. roseolus*.

Relationships in Smith & Zeller sect. *Rhizopogon*

Even though, the collections mentioned in Smith & Zeller (1966) are immensely valuable to *Rhizopogon* taxonomic and phylogenetic studies, our results reconfirm that the different subsections and stirps in sect. *Rhizopogon*, as based on peridium and gleba colours and basidiospore sizes, do not form monophyletic clades. Grubisha et al. (2002) taxonomic revision of the subgenera was a very important contribution.

Reexamination of all material distributed in the Ellis North America 943 Exsiccati is needed to reclassify the species. Zeller & Dodge (1918) included this collection under both *R. roseolus* (exsiccati in Mo. Bot. Gard. Herb and Burt Herb.) and *R. rubescens* (exsiccati in U.S. Dept. agr., Bur.PL, Ind. Path. Coll). Smith & Zeller (1966) also assigned the same exsiccati number (but located at NYBG and source for our own sequence) to *R. rubescens*.

Conclusions

As mentioned by Bidartondo & Bruns (2002) with respect to the genus *Gautieria*, many conflicts in the *R. roseolus* complex phylogeny probably stem from taxonomic concepts that vary from one continent to another. Collaborations among scientists around the world are required to solve the conflicts in species limits in *Rhizopogon*, as well as in other fungi.

Many papers published during recent years apply molecular taxonomic methods to study the ectomycorrhizal (EM) community structure, such as identifying resistant *Rhizopogon* propagules in post fire communities. However, before making conclusions, it is very important to ensure that sequences located at the public databases (such as EMBL, UNITE) are obtained from well-identified specimens. The taxonomic studies, although not always well funded and frequently neglected, are the basic to many applied research and application.

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Literature cited

- Acronym Search. 2001–06. Published on the Internet http://www.acronymsearch.com/documents/country_ISO_country_codes.htm [accessed 28 October 2007].
- Altschul SF, Madden TL, Schäffer AA, Zhang J, Zhang Z, Miller W, Lipman DJ. 1997. Gapped BLAST and PSI-BLAST: a new generation of protein database search programs. *Nucleic Acids Res.* 25: 3389–3402.
- Bidartondo MI, Bruns TD. 2002. Fine-level mycorrhizal specificity in the *Monotropoideae* (*Ericaceae*): specificity for fungal species groups. *Mol. Ecol.* 11: 557–569.
- Boudier E. 1885. Descriptions de quelques espèces nouvelles de champignons basidiosporés. *Bull. Soc. Bot. Fr.* 32: 282–304, pl. 9
- Corda ACJ. 1831. *Splanchnomyces roseolus* Corda. In Sturm, *Deutschl. Fl.*, 3. Abt., 3(11): 3.
- Corda ACJ. 1854. *Anleitung zum Studium der Mycologi*. 223 pp. Prague, Czechoslovakia.
- Farris JS. 1989. The retention index and the rescaled consistency index. *Cladistics* 5: 417–419.
- Felsenstein J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 39: 783–791.
- Fransson PMA, Anderson IC, Alexander IJ. 2007. Ectomycorrhizal fungi in culture respond differently to increased carbon availability. *FEMS Microbiol. Ecol.* 61: 246–257.
- Fries ThM. 1909. Skandinaviens tryffar och tryffelliknande Svampar. *Svensk Böttanisk Tidskrift* 3: 223–300.
- Groß G, Schmitt J. 1974. Beziehungen zwischen Sporenvolumen und Kernzahl bei einigen Höheren Pilzen. *Z. Pilzk.* 40: 163–214.
- Groß G, Runge A, Wintherhoff W. 1980. Bauchpilze (Gasteromycetes s.l.) in der Bundesrepublik Deutschland und Westberlin. *Beih. Z. Mykol.* 2: 1–92.
- Grubisha C, Trappe JM, Molina R, Spatafora JW. 2002. Biology of the ectomycorrhizal genus. VI. Re-examination of infrageneric relationships inferred from phylogenetic analyses of ITS sequences. *Mycologia* 94(4): 607–619.
- Huelsenbeck JP, Ronquist F. 2001. MRBAYES, Bayesian inference of phylogenetic trees. *Bioinformatics* 17: 754–755.
- Huelsenbeck JP, Rannala B, Masly JP. 2000. Accommodating phylogenetic uncertainty in evolutionary studies. *Science* 288: 2349–2350.
- Index Fungorum. 2004. Published on the Internet <http://www.indexfungorum.org/Names/Names.asp> [accessed 25 October 2007].
- Kausserud H, Svegården IB, Decock C, Hallenberg N. 2006. Hybridization among cryptic species of the cellar fungus *Coniophora puteana* (*Basidiomycota*). *Molecular Ecology* 16(2): 389–399.
- Johannesson H, Martín MP. 1999. Cladistic analysis of European species of *Rhizopogon* (*Basidiomycotina*) based on morphological and molecular characters. *Mycotaxon* 71: 133–140.
- Karsten PA. 1886. *Symbolae ad Mycologiam Fennicam*. Vol. 13. Helsinki.
- Karsten PA. 1889. *Finlands Basidsvampar*. pp. 1–25. Helsinki.
- Kluge AG, Farris JS. 1969. Quantitative phyletics and the evolution of anurans. *Systematic Zoology* 18: 1–32.
- Kjøller R, Bruns TD. 2003. *Rhizopogon* spore bank communities within and among California pine forest. *Mycologia* 95(4): 603–613.

- Kretzer AM, Luoma DL, Molina R, Spatafora JW. 2003 Taxonomy of the *Rhizopogon vinicolor* species complex based on analysis of ITS sequences and microsatellite loci *Mycologia* 95(3): 480–487.
- Larget B, Simon DL. 1999. Markov chain Monte Carlo algorithms for the Bayesian analysis of phylogenetic trees. *Mol. Biol. Evol.* 16: 750–759.
- Martin F, Díez J, Dell B, Delaruelle C. 2003. Phylogeography of the ectomycorrhizal *Pisolithus* species as inferred from nuclear ribosomal DNA ITS sequences. *New Phytol.* 153: 345–347.
- Martín MP. 1996. The genus *Rhizopogon* in Europe. Edc. Special Soc. Catalana Micol. Barcelona (Spain). 173 pp.
- Martín MP, Raidl S. 2002. The taxonomic position of *Rhizopogon melanogastroides* (Boletales). *Mycotaxon* 84: 221–228.
- Martín MP, Högborg N, Nylund JE. 1999. Molecular analysis confirms morphological reclassification of *Rhizopogon*. 102(7): 855–858.
- Martín MP, Kårén O, Nylund JE. 2000. Molecular ecology of hypogeous mycorrhizal fungi: *Rhizopogon roseolus* (Basidiomycotina). *Phyton* 40(4): 135–141.
- Menkis A, Vasiliauskas R, Taylor AFS, Stenlid J, Finlay R. 2005. Fungal communities in mycorrhizal roots of conifer seedlings in forest nurseries under different cultivation systems, assessed by morphotyping, direct sequencing and mycelial isolation. *Mycorrhiza* 16(1): 33–41.
- Pacioni G. 1984a. Champignons hypogés nouveaux pour l'Afrique du Nord. *Bull. Soc. Mycol. Fr.* 100(1): 111–124.
- Pacioni G. 1984b. Un nouvo fungo ipogeo raccolto in Sardegna: *Rhizopogon sardöus* n.sp. *Micol. Ital.* 2: 45–47.
- Page RDM. 1996. Treeview, an application to display phylogenetic trees on personal computers. *Comp. Appl. Biosci.* 12: 357–358.
- Rodriguez F, Oliver JF, Martín A, Medina JR. 1990. The general stochastic model of nucleotide substitution. *J. Theor. Biol.* 142: 485–501.
- Soehner E. 1956. Süddeutsche *Rhizopogon*-Arten. *Z. Pilzk.* 22(3): 65–80.
- Smith AH, Zeller SM. 1966. A preliminary account of the North American species of *Rhizopogon*. *Mem. N.Y. Bot. Gdn.* 14(2): 1–178.
- Svrček M. 1958. Hymenogastrales. In Pilát A. (ed.) *Flora C.S.R.B1 Gasteromycetes*. Pp. 123–140, 527–556. Praha.
- Swofford DL. 2003. PAUP*. Phylogenetic analysis using parsimony (*and other methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.
- Tedersoo L, Suvi T, Larsson E, Koljalg U. 2006. Diversity and community structure of ectomycorrhizal fungi in a wooded meadow. *Micol. Res.* 110(6): 734–748.
- Taylor DL, Bruns TD. 1999. Community structure of ectomycorrhizal fungi in a *Pinus muricata* forest: minimal overlap between the mature forest and resistant propagule communities. *Mol. Ecol.* 8(11): 1837–1850.
- Vacek V. 1948. Príspevek k poznání našich podezemek (Hypogei). *Česká Mykologie* 2: 58–64.
- Velenoský J. 1931. České druhy rodu *Rhizopogon* Fr. *Mykologia*, Praha 8: 89–94.
- Velenoský J. 1939. *Novitates Mykologicae. Pragae.* 211 pp.
- Vidal JM. 1991. Contribución al conocimiento de la flora micológica del Baix Empordà y zonas limítrofes (Catalunya). IV. Hongos hipogeos (*Zygomycotina*, *Ascomycotina* y *Basidiomycotina*). *Butll. Soc. Catalana Micol.* 14–15: 143–194.

APPENDIX 1. *Rhizopogon* DNA sequences analyzed in this study.

Commas separate 8 elements in the appendix below: 1—taxon name (in accordance with *Index Fungorum*) taken from the original collection label or reference (journal, book, GenBank); an asterisk (*) indicates a name not included in Smith & Zeller (1966) or Grubisha et al. (2002) and regarded as synonymous with *R. roseolus* in Martín (1996). 2—*Rhizopogon* spp. database alphanumeric codes (see also FIGS. 1–2). 3— collection number. 4— herbarium acronym (see Holmgren et al. 1990). 5 (when present)—type status. 6— collection area. 7—country code (ISO 3166 via acronymsearch.com). 8— GenBank accession numbers, with sequences obtained during this study in **bold** and those taken from GenBank referenced as follows: ^a = Grubisha et al. 2002, ^b = Johansson & Martín 1999, ^c = Kretzer et al. 2003, ^d = Martín & Raidl 2002, ^e = Fransson et al. 2007, ^f = Menkis et al. 2005, ^g = Tedersoo et al. 2006, ^h = Taylor & Bruns 1999; * denotes nrDNA ITS 1 (complete) + 5.8 S (partial) and ** denotes nrDNA 5.8S (partial) + ITS2 (complete). ? = *Boletus lupinus* Fr. and/or *Coniophora puteana* given as best BLAST scores. – = no sequence obtained.

- R. atrovioleaceus*, 1ATR, AHS 69179, E, paratype, Idaho, US, **AM085520***.
R. abietis, 1ABI, AHS 69834, MICH, paratype, Idaho, US, –.
R. abietis, 2ABI, MPM 530, BCC, Girona, ES, –.
R. colossus, 1COL, AHS 49480, MICH, holotype, Oregon, US, AF071441^a, AF071442^a.
R. diabolicus, 1DIA, AHS 68424, MICH, paratype, Idaho, US, AF071444^a, AF071443^a.
*R. duriusculus**, 1DUR, PRM 154791, holotype, Mnichovice, CZ, ? .
R. ellenae, 2ELL, AHS 66137, MICH, holotype, Idaho, US, AF071445^a, AF071446^a.
R. fragrans, 1FRA, AHS 60155, MICH, paratype, Idaho, US, **AM085523**.
*R. gigasporus**, 1GIG, AQU1, holotype, Tabarka, TN, **AJ810044***.
R. graveolens f. *pomaceus**, 1POM, PRM 619028, isotype, Právcice, CZ, **AJ810037**.
R. graveolens f. *pomaceus**, 2POM, PRM 619033, isotype, Právcice, CZ, ? .
R. hawkeriae, 1HAW, AHS 68417, MICH, Washington, US, AF071447^a, AF071448^a.
*R. inodorus**, 1INO, PRM 148574, Jilové, CZ, –.
*R. lapponicus**, 1LAP, P.A. Karsten 3695, H, type, Rossia Karelia, FI, –.
*R. lapponicus**, 2LAP, P.A. Karsten 3696, H, type, Rossia Karelia, FI, –.
R. luteolus, 1LUT, JMT 22516, OSC, Uppsala, SE, AF062936^a.
R. luteorubescens, 1LRU, AHS 58778, MICH, holotype, Idaho, US, **AJ810038**.
R. minor, 1MIN, PRM 154798, type, Mnichovice, CZ, –.
R. mohelnensis, 1MOH, PRM 154616, type, Moheno, CZ, **AJ810039**, ? .
R. ochraceisporus, 1OCI, AHS 65963, MICH, paratype, Idaho, US, AF071439^a.
R. ochraceorubens, 2ORU, AHS 59643, MICH, holotype, Idaho, US, AF062928^a.
R. ochroleuroides, 1OLE, AHS 68310, MICH, paratype, Idaho, US, – .
R. pseudoroseolus, 1PSE, AHS 66302, MICH, paratype, Michigan, US, **AJ810040**.
R. pseudoroseolus, 2PSE, AHS 66604, MICH, paratype, Michigan, US, **AJ810041**.
R. pseudoroseolus, 3PSE, AHS 66469a, MICH, paratype, Michigan, US, **AJ810042**.
R. pumilionus *, 1 PUM–2PUM, ex herb Soehner 1184, M, type, DE, –,–.
R. roseolus sensu Trappe, 1ROS, JMT 8227, OSC, California, US, AF058315^a.
R. roseolus sensu A.H. Sm., 2ROS, AHS 65485, MICH, Idaho, US, **AJ810045**.
R. roseolus sensu M.P. Martín, 3ROS–11ROS, 1–9 MPM2714, MA–Fungi 47710, Gozd Martuljek, SI, **AJ810046–AJ810054**.
R. roseolus, 12ROS, MPM2717, MA–Fungi 47711, Huesca, ES, **AJ810055**.
R. roseolus, 13ROS, MPM2725, MA–Fungi 47688, Ávila, ES, AJ419209^d.

- R. roseolus*, 14ROS, MPM2819, MA-Fungi 47689, Girona, ES, AJ419211^d.
- R. roseolus*, 15ROS, MPM2858, MA-Fungi 47687, Estremadura, PT, AJ419210^d.
- R. roseolus*, 16ROS–17ROS, MPM2898, MA-Fungi 47712, Tarragona, ES, **AJ810056**, –.
- R. roseolus*, 18ROS, MPM2911, MA-Fungi 47713, Castellón, ES, **AJ810057**.
- R. roseolus*, 19ROS–20ROS, 1–2 MPM2912, MA-Fungi 47714, Castellón, ES, **AJ810058**, **AJ810059**.
- R. roseolus*, 21ROS–22ROS, 1–2 MPM2913, MA-Fungi 47715, Castellón, ES, **AJ810060****, **AJ810061****.
- R. roseolus*, 23ROS–28ROS, 1–6 MPM2917, MA-Fungi 47716, Tarragona, ES, from **AJ810062** to **AJ810067**.
- R. roseolus*, 29ROS, MPM2918, MA-Fungi 47717, Tarragona, ES, –.
- R. roseolus*, 30ROS–31ROS, 1–2 MPM2921, MA-Fungi 47718, Tarragona, ES, **AJ810068****, **AJ810069****.
- R. roseolus*, 32ROS–35ROS, 1–4 MPM2922, MA-Fungi 47719, Tarragona, ES, from **AJ810070** to **AJ810073**.
- R. roseolus*, 36ROS, MPM2928, MA-Fungi 47720, Castellón, ES, **AJ810074**.
- R. roseolus*, 37ROS, MPM 1511, BCC, Mallorca, ES, AF115840^{**b}.
- R. roseolus*, 38ROS, Sarasini 286, S. Vincenzo, IT, AF115841^{**b}.
- R. roseolus*, 39ROS, Sarasini 451, Marina di Vecchiano, IT, AF115842^{**b}.
- R. roseolus*, 40ROS, Sarasini 521, Girona, ES, AF115843^{**b}.
- R. roseolus*, 41ROS, Sarasini 612, Fondo, IT, AF115844^{**b}.
- R. roseolus*, 42ROS, isolate RrUP175 (ectomycorrhiza root tip), Uppsala, SE, DQ179127^e.
- R. roseolus*, 43ROS, strain NA202A (ectomycorrhiza root tip), LT, DQ068964^f.
- R. roseolus*, 44ROS, L999, TAA 185325, Karuse, EE, AJ966744^g.
- R. roseolus* f. *amygdaloporus*^{*}, 1AMY, UPS, Närke, SE, –.
- R. roseolus* f. *aberrans*^{*}, 1ABE, UPS, Uppland, SE, –.
- R. roseolus* f. *foetens*^{*}, 1FOE, PRM 618989, Pradice, CZ, ?.
- R. rubescens*, 1RUB, RPC-13 (ectomycorrhiza root tip), California, US, AF158018^h.
- R. rubescens*, 2RUB, Ellis North Amer. 943 Exsiccati, M, New Jersey, US, **AJ810034**.
- R. rubescens*, 3RUB, MPM2815, MA-Fungi 47730, Girona, ES, **AM085528**.
- R. rubescens*, 4RUB, isolate aurim738 (ectomycorrhiza root tip), LT, DQ069016^f.
- R. rubescens*, 5RUB, isolate NS182 (ectomycorrhiza root tip), LT, DQ068965^f.
- R. rubescens* var. *ochraceus*, 1OCH, AHS 60079, UPS, paratype, Idaho, US, –.
- R. rubescens* var. *ochraceus*, 2OCH, AHS 59481, UPS, paratype, Idaho, US, –.
- R. rubescens* var. *pallidimaculatus*, 1PAL, AHS 58821a, MICH, holotype, Idaho, US, **AJ810043**.
- R. sardous*^{*}, 1SAR, AQU1, Sardegna, IT, **AM085529**.
- R. tenuisporus*^{*}, 1TEN, PRM 19570, lectotype, Sobeslav-Blata, CZ, ?.
- R. tenuisporus*^{*}, 2TEN, PRM 154619, syntype, Sobeslav-Blata, CZ, ?.
- “*R. tenuisporus* var. *intermedius*”^{*}, 3TEN, PRM 742575, type, Bzenec, CZ, ?, –.
- R. ventricisporus*, 1VEN, AHS 69165, MICH, holotype, Idaho, US, –.
- R. vinicolor*, 2VIN, Trueblood 2195, MICH, holotype, Idaho, US, **AJ810035**.
- R. vulgaris*, 1VUL, JMT 19154, OSC, Oregon, US, AF062934^a.
- R. vulgaris*, 2VUL, JMT 17998, OSC, California, US, AF062931^a.

***Dothiorella viticola* on *Populus cathayana* in China: a new record**

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Abstract — We document the first report of the species *Dothiorella viticola* (teleomorph: *Spencermartinsia viticola*) from China. This fungus was isolated from the bark of *Populus cathayana* collected from Qianyang, Shaanxi Provinces. Morphological characteristics of the anamorph indicated that it was a *Dothiorella* species, and phylogenetic analysis based on rDNA-ITS data confirmed that the isolate should be included within *Spencermartinsia*. Conidiogenesis, observed in pycnidia obtained in culture, was holoblastic with conidiogenous cells proliferating at the same level giving rise to periclinal thickenings. Conidia were brown, thick-walled and septate with both ends rounded or with a truncate base.

Key words — *Botryosphaeriaceae*, internal transcribed spacer.

Introduction

Species of *Botryosphaeria* Ces. & De Not. are well known as pathogens, saprophytes, and endophytes on a wide range of woody angiosperm and gymnosperm hosts (Barr 1972, von Arx 1987, Denman et al. 2000). While the morphology of the teleomorphic states differs little among species, a wide range of morphologies is seen in the anamorphs and it is on this basis that species are distinguished. Anamorphs of *Botryosphaeria* species currently are placed in the genera *Fusicoccum* Corda, *Diplodia* Fr., *Lasiodiplodia* Ellis & Everh., and *Dothiorella* Sacc. (Crous & Palm 1999, Denman et al. 2000, Phillips et al. 2005). These four genera are clearly distinct based on morphology and their

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phylogenetic relationships, as shown by analysis of sequence data of the internal transcribed spacer (ITS) of the rRNA repeat (Phillips et al. 2005).

The genus *Dothiorella* was resurrected to accommodate anamorphs of *Botryosphaeria* species with conidia that become colored and septate at an early stage of development, even before they are released from the conidiogenous cell (Phillips et al. 2005). This contrasts with conidia of *Diplodia* species, which are hyaline and become dark and septate only some time after they are formed, normally after a period of aging once they are discharged from the pycnidia (Shoemaker 1964, Alves et al. 2004, Phillips et al. 2005). Another distinctive morphological feature of *Dothiorella* anamorphs is their brown, one-septate ascospores (Shoemaker 1964, Sivanesan 1984, Alves et al. 2004).

This paper reports the identification of *Dothiorella viticola* A.J.L. Phillips & J. Luque, isolated from *Populus cathayana* in China. *Dothiorella viticola* (teleomorph: *Botryosphaeria viticola*) was described and illustrated in Luque et al. (2006), from pruned canes of *Vitis vinifera* in NE Spain. Recently, the teleomorph has been recombined as *Spencermartinsia viticola* (A.J.L. Phillips & J. Luque) A.J.L. Phillips et al., the sole species in the new genus *Spencermartinsia* (Phillips et al. 2008).

Materials and methods

ISOLATES. Pieces of diseased tissue were plated on potato dextrose agar (PDA) after 2 min of surface sterilization in 70% ethanol. Sporulation was enhanced by culturing the isolates on 2% water agar bearing pieces of autoclaved poplar branch at 25°C with a 12/12 h photoperiod. Growth rates were determined on PDA plates incubated in the dark at 25°C.

DNA SEQUENCING. Template DNA was extracted from fungal mycelium according to the method of Barnes et al. (2001), and primer pairs used for amplification and sequencing of the ITS region were ITS1-F (Gardes et al. 1993) and ITS4 (White et al. 1990). Amplification was completed with the following cycling parameters: initial denaturation at 94°C for 3 min followed by 35 cycles of denaturation at 94°C for 30 s, annealing at 52°C for 30 s, and extension at 72°C for 10 min. The PCR products were sequenced by Organism Technology Co., Ltd., Shanghai, China. Accession Number in GenBank is FJ786401 for isolate QY02.

The ITS nucleotide sequences generated in this study were added to other sequences downloaded from GenBank (Table 1), with high similarity according to a BLAST search (National Center for Biotechnology Information's nucleotide blast program). Preliminary alignments were performed using CLUSTAL-X. The alignments were imported into BioEdit 5.0.9.1 and manually adjusted. Phylogenetic analysis of aligned DNA sequences was performed with PAUP version 4.0b10 for 32-bit Microsoft Windows (Swofford 2001). Heuristic searches were performed with 1000 random sequence additions. The clade stability was evaluated by 1000 bootstrap replications. Other measures for parsimony, including tree length, consistency index, retention index and rescaled consistency index (CI, RI and RC, respectively), were also calculated. *Cercospora apii* was used as the outgroup taxon.

TABLE 1. Sequences used in the phylogenetic analysis of *Spencermartinsia* and *Botryosphaeria*.

SPECIES	GENBANK CODE	HOST	REFERENCE
<i>Spencermartinsia viticola</i>	FJ786401	<i>Populus cathayana</i>	This paper
<i>S. viticola</i>	AY905555	<i>V. vinifera</i>	Luque et al. 2006
<i>S. viticola</i>	AY905556	<i>V. vinifera</i>	Luque et al. 2006
<i>S. viticola</i>	AY905557	<i>V. vinifera</i>	Luque et al. 2006
<i>S. viticola</i>	AY905558	<i>V. vinifera</i>	Luque et al. 2006
<i>B. australis</i>	AY343388	<i>V. vinifera</i>	Van et al. 2004
<i>B. australis</i>	AY343385	<i>V. vinifera</i>	Van et al. 2004
<i>B. corticola</i>	AY259100	<i>Quercus suber</i>	Alves et al. 2004
<i>B. corticola</i>	AY259089	<i>Q. suber</i>	Alves et al. 2004
<i>B. dothidea</i>	AY640253	<i>Populus nigra</i>	Phillips et al. 2005
<i>B. dothidea</i>	AY259092	<i>V. vinifera</i>	Alves et al. 2004
<i>B. iberica</i>	AY573202	<i>Quercus ilex</i>	Phillips et al. 2005
<i>B. iberica</i>	AY573214	<i>Q. ilex</i>	Phillips et al. 2005
<i>B. iberica</i>	AY573213	<i>Q. ilex</i>	Phillips et al. 2005
<i>B. lutea</i>	AY259091	<i>V. vinifera</i>	Alves et al. 2004
<i>B. lutea</i>	AY236946	<i>Malus ×domestica</i>	Slippers et al. 2004
<i>B. sarmentorum</i>	AY573206	<i>Malus pumila</i>	Phillips et al. 2005
<i>B. sarmentorum</i>	AY573212	<i>Ulmus</i> sp.	Phillips et al. 2005
<i>B. stevensii</i>	AY259093	<i>V. vinifera</i>	Alves et al. 2004
<i>B. stevensii</i>	AY236955	<i>Fraxinus excelsior</i>	Slippers et al. 2004
<i>B. rhodina</i>	AY236952	<i>Pinus</i> sp.	Slippers et al. 2004
<i>B. rhodina</i>	AY236951	<i>Vitex doniana</i>	Slippers et al. 2004
<i>B. obtusa</i>	AY259094	<i>V. vinifera</i>	Alves et al. 2004
<i>B. obtusa</i>	AY236954	<i>Ribes</i> sp.	Slippers et al. 2004
<i>B. parva</i>	AY236943	<i>P. nigra</i>	Slippers et al. 2004
<i>B. parva</i>	AY259098	<i>V. vinifera</i>	Alves et al. 2004
<i>Cercospora apii</i>	AY179949	Unknown	Mostert et al. 2003

Results

Isolate QY02 was obtained in China from diseased tissue of *P. cathayana*, where it forms dark-brown, wart-like protuberances on the surface of trunks and branches. The warts on trunks and branches damage the tree, reducing its growth and productivity. colonies on PDA showed aerial mycelium and were cottony, dark olive to grayish, darkening from the center of the colony after 3 d; colony fully darkened after 6–10 d. Colonies on PDA reached 40 mm radius after 3 d at 25°C. PYCNIDIA were produced after 20–30 d on 2% water agar at 23°C under near UV black light (12/12 h photoperiod). CONIDOMA pycnidial, separate or aggregated into botryose clusters up to 2 mm diam, individual pycnidia

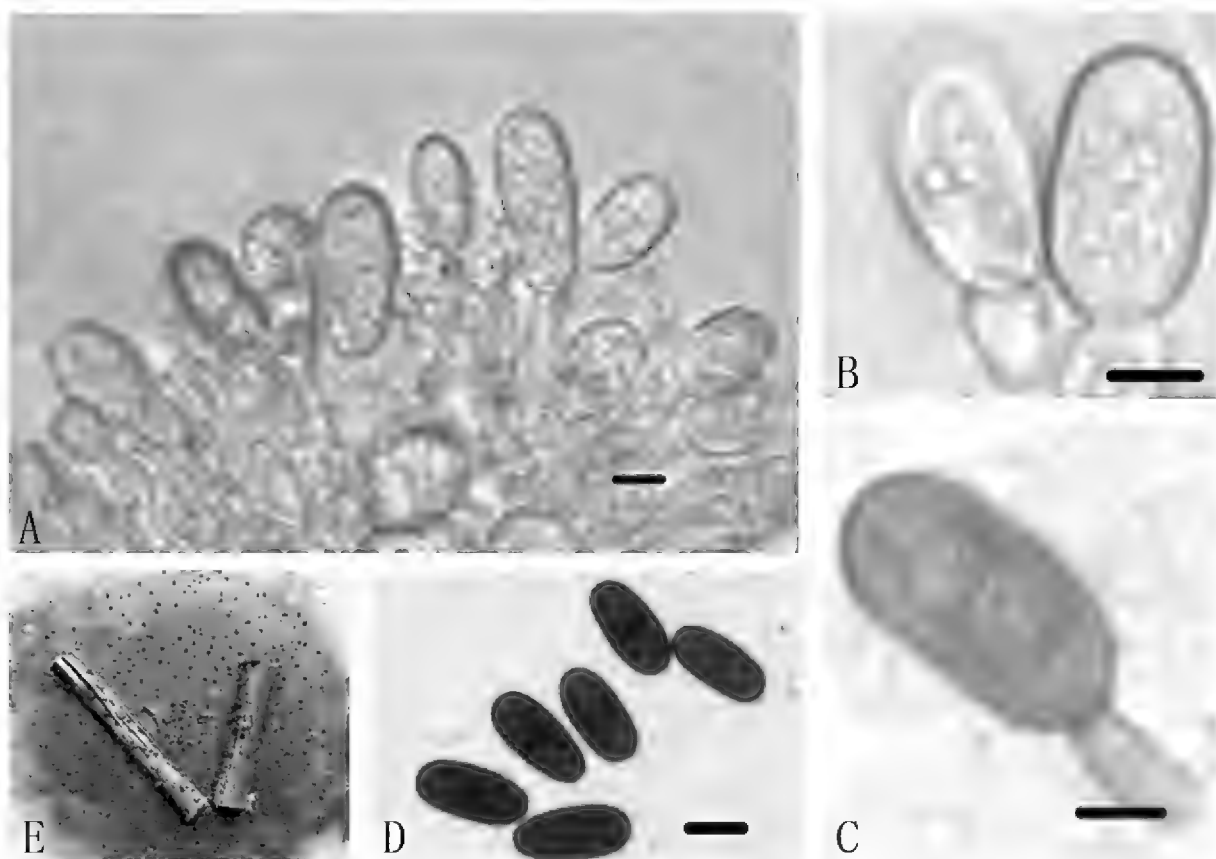


FIG. 1 A–D. Conidiogenous cells and conidia of *Dothiorella viticola* (*Spencermartinsia viticola*) Isolate QY02. B–C. Conidiogenous cell with periclinal thickenings. D. Conidia dark-brown, one-septate. E. Colony on water agar containing pieces of autoclaved poplar wood after 30d. Bars A–C = 5 μ m, D = 10 μ m

spherical to globose, black, unilocular, 200–360 μ m diam, thick-walled, walls exhibiting three layers: an outer layer of dark brown, thick-walled cells *textura angularis*, a median layer of dark brown thin-walled cells *textura angularis*, and an inner layer of thin-walled, hyaline cells. CONIDIOPHORES hyaline, cylindrical, branched. CONIDIOGENOUS CELLS discrete or integrated, cylindrical to broad lageniform, 8–14 \times 3–7 μ m, hyaline, smooth, holoblastic, indeterminate, proliferating at same level to form periclinal thickenings. CONIDIA brown, oblong to subcylindrical, septate, occasionally slightly constricted at septum, moderately thick-walled, externally smooth, internally finely verruculose, ends rounded, often with a truncate base, 16–26 \times 7–12 μ m.

A multiple alignment of the rDNA-ITS was generated with 27 sequences obtained from GenBank plus the sequence of isolate QY02 from *Populus cathayana*. Two major clades were resolved in a MP tree with 242 length (CI = 0.8023, RI = 0.9272, RC = 0.7931) (FIG. 2). One clade, with 90% bootstrap support, contained four species with *Diplodia* and *Lasiodiplodia* anamorphs. The other major clade (83% bootstrap) consisted of three subclades containing isolates with *Fusicoccum* and *Dothiorella* anamorphs. The *Dothiorella* species grouped in a well-supported subclade (74%). Isolate QY02 and the five

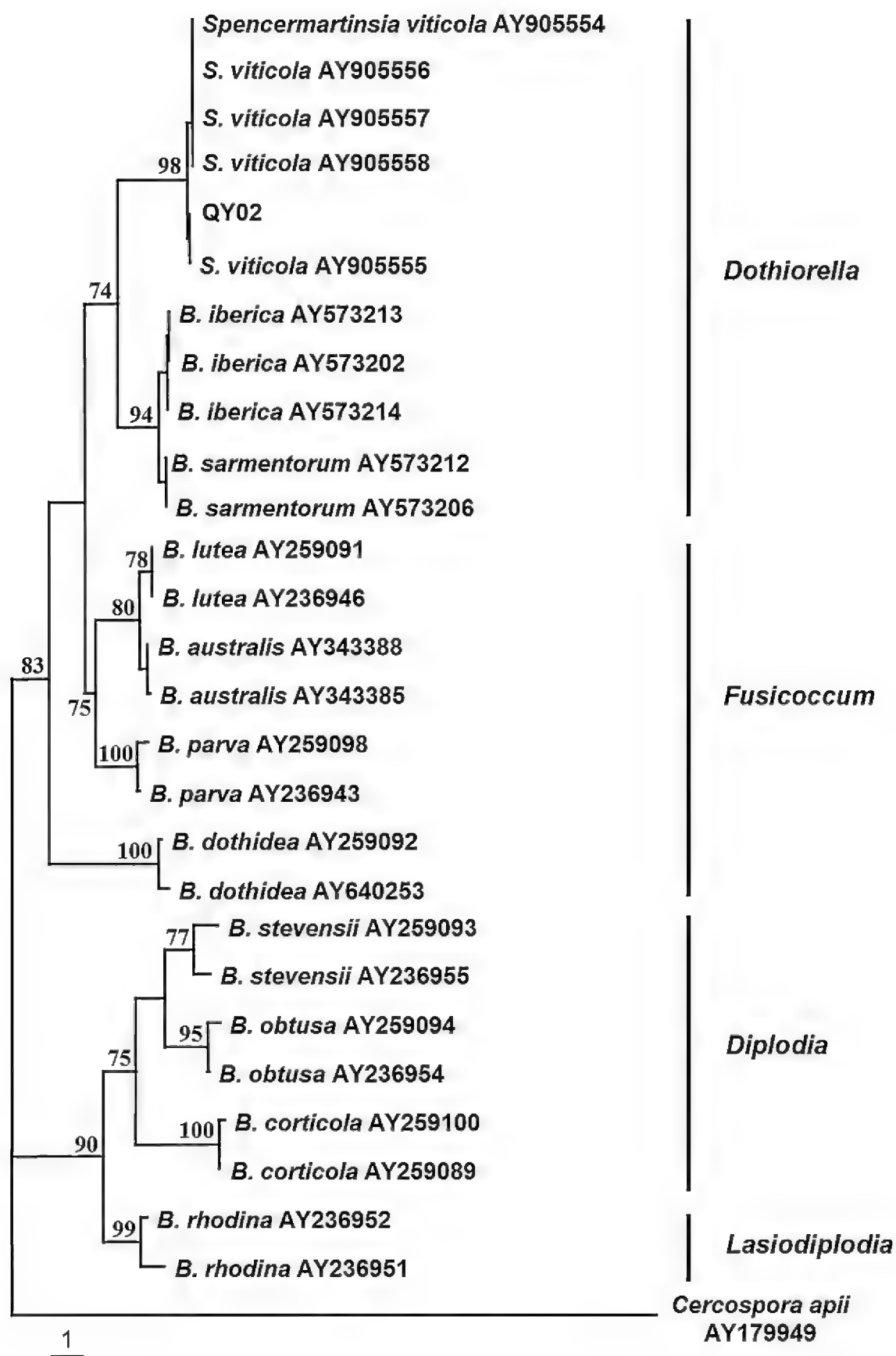


FIG. 2 The parsimony tree (TL = 242, CI = 0.8023, RI = 0.9272, RC = 0.7931) derived from a heuristic search option in PAUP version 4.0b10 with 1000 randomizations of sequence input orders and 1000 bootstrap replications using the data set of ITS1, 5.8S and ITS2. Bootstrap values higher than 70% are indicated above or below the tree branches. The tree was rooted to *Cercospora apii*. Anamorph genera are indicated on the right.

S. viticola isolates from *Vitis vinifera* identified by Luque et al. (2006; as *B. viticola*) fell within a single clade with 98% bootstrap support.

Discussion

Based on phylogenetic analysis of the ITS region and morphological characters of the anamorph, we identified isolate QY02 as *Dothiorella viticola* (teleomorph: *Spencermartinsia viticola*). This study is the first report of *D. viticola* from poplar. This species was first described from grapevines (Luque et al. 2006) and previously known only from that host. The anamorph is morphologically distinct from *Diplodia* and can be accommodated in the genus *Dothiorella*. With *Botryosphaeria iberica* A.J.L. Phillips et al. and *B. sarmentorum* A.J.L. Phillips et al., *S. viticola* is the third species known to have an anamorph in *Dothiorella*. These three species are morphologically similar, but their differences are well supported by the ITS data (Luque et al. 2006). The teleomorph of *S. viticola* is reported to be “uncommon” on *Vitis vinifera* (Luque et al. 2006). Despite careful examination of diseased trunks and branches of *Populus cathayana*, we have not yet been able to find signs of the teleomorph of this fungus.

Acknowledgments

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Literature cited

- Alves A, Correia A, Luque J, Phillips AJL. 2004. *Botryosphaeria corticola* sp. nov. on *Quercus* species, with notes and description of *Botryosphaeria stevensii* and its anamorph *Diplodia mutila*. *Mycologia* 96: 598–613.
- Barnes I, Gaur A, Burgess T, Roux J, Wingfield BD, Wingfield MJ. 2001. Microsatellite markers reflect intra-specific relationships between isolates of the vascular wilt pathogen, *Ceratocystis fimbriata*. *Mol. Plant Pathol.* 2: 319–325.
- Barr ME. 1972. Preliminary studies on the *Dothideales* in temperate North America. *Contr. Univ. Michigan Herb.* 9: 523–638.
- Crous PW, Palm ME. 1999. Reassessment of the anamorph genera *Botryodiplodia*, *Dothiorella* and *Fusicoccum*. *Sydowia* 51: 161–175.

- Denman S, Crous PW, Taylor JE, Kang J-C, Pascoe I, Wingfield MJ. 2000. An overview of the taxonomic history of *Botryosphaeria*, and a re-evaluation of its anamorphs based on morphology and ITS rDNA phylogeny. *Stud. Mycol.* 45: 129–140.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes – application to the identification of mycorrhizae and rusts. *Mol. Ecol.* 2: 113–118.
- Luque J, Martos S, Phillips AJL. 2006 (“2005”). *Botryosphaeria viticola* sp. nov. on grapevines: a new species with a *Dothiorella* anamorph. *Mycologia* 97: 1111–1121.
- Mostert L, Crous PW, Groenewald JZ, Gams W. 2003. *Togninia* (*Calosphaeriales*) is confirmed as teleomorph of *Phaeoacremonium* by means of morphology, sexual compatibility and DNA phylogeny. *Mycologia* 95: 646–659.
- Phillips A, Alves A, Correia A, Luque J. 2005. Two new species of *Botryosphaeria* with brown, 1-septate ascospores and *Dothiorella* anamorphs. *Mycologia* 97: 513–529.
- Phillips AJL, Alves A, Pennycook SR, Johnston PR, Ramaley A, Akulov A, Crous PW. 2008. Resolving the phylogenetic and taxonomic status of dark-spored teleomorph genera in the *Botryosphaeriaceae*. *Persoonia* 21: 29–55.
- Shoemaker RA. 1964. Conidial states of some *Botryosphaeria* species on *Vitis* and *Quercus*. *Can. J. Bot.* 42: 1297–1303.
- Sivanesan A. 1984. The bitunicate ascomycetes and their anamorphs. Vaduz, Liechtenstein: J. Cramer. 701 p.
- Slippers B, Crous PW, Denman S, Countinho TA, Wingfield BD. 2004. Combined multiple gene genealogies and phenotypic characters differentiate several species previously identified as *Botryosphaeria dothidea*. *Mycologia* 96: 83–101.
- Swofford DL. 2001. PAUP*. Phylogenetic analysis using parsimony (*and other methods) version 4.0 beta version. Sinauer Associates, Sunderland, Massachusetts, U.S.A.
- Van Niekerk JM, Crous PW, Groenewald JZE. 2004. DNA phylogeny, morphology and pathogenicity of *Botryosphaeria* species on grapevines. *Mycologia* 96: 781–798.
- von Arx JA. 1987. Plant Pathogenic Fungi. *Nova Hedwigia Beih.* 87: 288 p.
- White TJ, Bruns TD, Lee SB, Taylor JW. 1990. Analysis of phylogenetic relationships by amplification and direct sequencing of ribosomal RNA genes. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds) *PCR protocols: a guide to methods and applications*. Academic, New York, pp. 315–322.

Additional lichen records from Giresun Province, Turkey

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Abstract – A total of 299 lichen taxa are presented from 52 sampling stations in the Turkish province of Giresun. Of these 5 species are new to Turkey, viz. *Biatora cuprea*, *Collema dichotomum*, *Gyalecta foveolaris*, *Umbilicaria virginis* and *Verrucaria fusconigrescens*, and 110 species are new to Giresun. The complete checklist is available on <http://www.mycotaxon.com/resources/weblists.html>.

Key words – biota, biodiversity, Karagöl Mountains

Introduction

Despite intense lichenological field activity in Turkey in recent years, many areas remain poorly known with respect to their lichen biota. As to Giresun province, until now 14 research articles on its lichen biota have been published (Aslan et al. 2002, Aslan & Yazıcı 2006, Duman & Yurdakulol 2007, Halıcı & Şenkardeşler 2009, John & Breuss 2004, Kınalıoğlu 2005, 2006, 2008, Kınalıoğlu & Engin 2004, Küçük 1990, Özgen et al. 2003, Steiner 1909, Süleyman et al. 2002, Yazıcı 2006, Yazıcı & Aptroot 2008). However, these studies still do not give an adequate picture of the lichen biota of Giresun as new fieldwork by the author has shown. This provided many additions to our knowledge of the lichens of Giresun and Turkey, which are presented below.

The study area

Giresun is located in the eastern part of the Black Sea region of Turkey (Fig. 1), at the boundary of the Euxianian section of the Euro-Siberian Phytogeographical Region. It is situated between 40°07' 41°08' N and 37°50' 39°12' E at altitudes ranging from sea level to 3331 m. The province has a surface of 6934 km², mostly of rough topography. The most important altitudes of Giresun are Abdal Musa peak (3331 m), Cankurtaran peak (3278 m), Gâvur mountain peak (3067 m), Küçükkor peak (3044 m), Karagöl mountains (3107 m) and Kırkkızlar peak

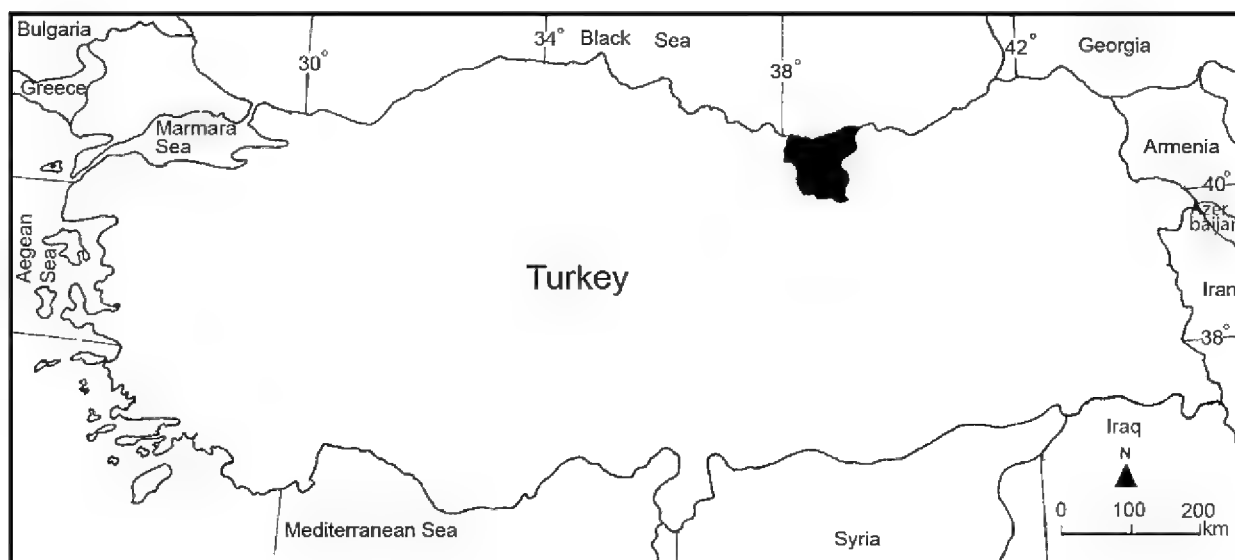


FIG. 1. Map of Turkey showing Giresun province.

(3040 m). The mountainous landscape has many rock outcrops, predominantly consisting of siliceous rocks. Upper Cretaceous volcanic deposits (agglomerata, basalt, dacite, granodiorit) are mostly present in the northern of Giresun, while deposits of Oligocene and Miocene (gypsiferous, dolorite, andesite) are quite large in the southern of province. There are various glacial lakes in the Karagöl mountains. The most important of these lakes is Karagöl lake. Around Karagöl lake patches of snow and ice persist even in the summer months. Small plains exist near the coastal area. The wide altitudinal variation, rough topography, influence of the adjacent sea, and big streams provide a wide range of climatic conditions though large parts of Giresun has an oceanic climate. Following Emberger's principles, Akman (1990) reports that the mean precipitation-temperature coefficient (Q) is 202 and the aridity index (S) is 9.5 for Giresun. The mean rainfall per year is 1271.7 mm and the rainfall regime is 'Oceanic Rain Regime Marina Type I.' The mean annual maximum temperature is 26.6°C in August, while the mean minimum temperature is 4.3°C in February. The mean annual relative humidity is 76%. The vegetation is equally varied. The northern slopes, up to 800 m, have deciduous trees of *Corylus* spp., *Alnus* spp., *Carpinus orientalis* and *Castanea sativa*. The dominant *Corylus* spp. are an important crop plant. From 800 to 1500 m *Fagus orientalis* is dominant. It is often accompanied by *Carpinus betulus*, *Picea orientalis*, *Rhododendron ponticum*, *Ulmus glabra* and *Quercus hartwissiana*. At 1500 2000 m the forest consists of *Picea orientalis* together with *Pinus sylvestris* and *Abies nordmanniana* subsp. *nordmanniana* (Anşin 1981). These provide suitable habitats for a rich lichen flora. Above 2000 m alpine meadows are dominant. The southern part of the province is mostly covered with xerophytic oak woodland and steppe vegetation.

Materials and methods

Inventorying was done in 52 localities spread over the province. The resulting specimens were identified following the standard identification methods and using mostly the following lichen guides: Brodo et al. 2001, Purvis et al. 1992, Wirth 1995. The samples were air dried and examined using a stereomicroscope and a light microscope. Vouchers are deposited in the herbarium of the Faculty of Science and Arts, Giresun University, Giresun, Turkey. Duplicates of some specimens studied by Etayo and Sipman are kept in their respective herbaria.

Results and discussion

The five species reported here as new for Turkey, *Biatora cuprea*, *Collema dichotomum*, *Gyalecta foveolaris*, *Umbilicaria virginis* and *Verrucaria fusconigrescens*, appear to be rather widespread elsewhere and have probably been overlooked previously. *Verrucaria fusconigrescens* was collected from siliceous rocks at the sea shore. It is reported to grow commonly on sunny siliceous rocks in the sublittoral zone on seashores in Europe and N America (Purvis et al. 1992). The coastlines of Turkey are valuable areas in the terms of lichen biota, but the areas have been neglected so far for lichens. Further species rarely recorded in Turkey so far include *Biatora vernalis*, *Buellia abstracta*, *Collema polycarpon* subsp. *corcyrense*, *Staurothele catalepta*, *Toninia squalida*, *Umbilicaria aprina* and *Staurolemma omphalarioides*. According to the literature (see introduction), 328 lichen taxa are reported from Giresun. Together with the additional records from this study the number of lichen taxa known from Giresun now reaches 431. However, additional studies remain necessary to complete the inventory of the lichen biota of Giresun. Especially the southernmost regions of the province are poorly explored. The wide altitudinal range, rough topography and maritime influence of Giresun offer a wide range of niches so that a rich lichen biodiversity can be expected.

Acknowledgements

The identification of numerous samples by Dr. H. Sipman (Berlin, Germany), Dr. J. Etayo (Pamplona, Spain) and Prof. T. Ahti (Helsinki, Finland) is gratefully acknowledged. I also thank peer-reviewers Dr. P. Divakar & Dr. H. Sipman for their contributions on revising article.

Literature cited

- Akman Y. 1999. İklim ve Biyoiklim (Biyoiklim Metodları ve Türkiye İklimleri). Palme Yayın Dağıtım, Mühendislik Serisi, Ankara.
- Anşın R. 1981. Doğu Karadeniz Bölgesi Sahil ve iç Kesiminde Yayılan Ana Vejetasyon Tipleri. Karadeniz Teknik Üniversitesi, Orman Fakültesi Dergisi 4(1): 14–25.
- Aslan A. Aptroot A, Yazıcı K. 2002. New lichens for Turkey. Mycotaxon 84: 227–280.

- Aslan A, Yazıcı K. 2006. Contribution to the lichen flora of Giresun Province of Turkey. *Acta Botanica Hungarica* 48(3 4): 231–245.
- Brodo IM, Sharnoff SD, Sharnoff S. 2001. *Lichens of North America*, Yale University Press, London.
- Duman C, Yurdakulol E. 2007. Lichen Records from Sarıçiçek Mountain in Southern Giresun Province, Turkey. *Turk. J. Bot.* 31: 357–365.
- Halıcı MG, Şenkardeşler A. 2009. Giresun için yeni kayıt: *Phaeosporobolus usneae*. *Türk Lichen Toluluğu Bülteni* 7: 11–12.
- John V, Breuss O. 2004. Flechten der östlichen Schwarzmeer-Region in der Türkei (BLAM Exkursion 1997). *Herzogia* 17: 137–156.
- Kınalıoğlu K. 2005. Lichens of Giresun District, Giresun Province, Turkey. *Turkish Journal of Botany* 29: 1–7.
- Kınalıoğlu K. 2006. Lichens of Keşap District (Giresun, Turkey). *Acta Botanica Hungarica* 48(12):65–76.
- Kınalıoğlu K. 2008. Three new records for the lichen biota of Turkey. *Mycotaxon* 103: 123–126.
- Kınalıoğlu K, Engin A. 2004. Bülbülan (Artvin), Ayder, Anzer (Rize), Kalecik (Trabzon) ve Kümbet (Giresun) Yaylalarının Lichenleri. *Ot Sistematik Botanik Dergisi Bot.* 11(2): 167–190.
- Küçük M. 1990. Giresun Adası'nın Floristik Yapısı. *Ormançılık Araştırma Enstitüsü Yayınları* 36(2): 58.
- Özgen U, Aslan A, Terzi Z. 2003. Phytochemical screening of some lichen species collected from Giresun Province. I. International Congress on the Chemistry of Natural Products (ICNP) 16 19 October, Trabzon, Türkiye.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992. *The Lichen Flora of at Britain and Ireland*. Natural History Museum & British Lichen Society, London.
- Roux C, Sérusiaux E, Bricaud O, Coppins B. 2004: Le genre *Strigula* (Lichens) en Europe et en Macaronésie. *Bibliotheca Lichenologica* 90, J. Cramer, Berlin, Stuttgart.
- Steiner J. 1909. Lichenes. In: Handel Mazzetti, D.H.F.V.: *Ergebnisse einer botanischen Reise in das Pontische Randgebirge im Sandschak Trapezunt, etc.* *Annal. Naturhist. Hofmus. Wien* 23: 107–123.
- Süleyman H, Yıldırım D, Aslan A, Göçer F, Gepdiremen A, Güvenalp Z. 2002. An investigation of the antiinflammatory effects of an extract from *Cladonia rangiformis* Hoffm.-*Biol. and Pharm. Bull.* 25: 10–13.
- Wirth V. 1995. *Die Flechten Baden-Württembergs*. Ulmer, Stuttgart.
- Yazıcı K. 2006. Four new lichens from Turkey. *Myxotaxon* 95: 315–331
- Yazıcı K, Aptroot A. 2008. Corticolous lichens of the city of Giresun with descriptions of four species new to Turkey. *Mycotaxon* 105: 95–104.

Corticoid fungi (*Basidiomycota*) from the Azores Islands: Flores and São Miguel

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Abstract — The catalogue of corticoid fungi from Flores and São Miguel Islands (Azores archipelago) is presented. The study covered 29 localities and 644 samples were analyzed. This catalogue includes 83 species, of which 32 are new to the archipelago. They belong to 37 genera. *Trechispora* (9 species), *Hyphodontia* (7 species), *Peniophora* (6 species), and *Tubulicium* (4 species) are the most significant genera. A remarkable feature is the presence in the archipelago of *Peniophora bicornis*. The complete catalogue is available in <http://www.mycotaxon.com/resources/weblist.html>.

Key words — *Aphyllphorales*, fungal diversity, lignicolous fungi, Macaronesia, Portugal, species inventory

Introduction

The Azores archipelago, located close to the Mid-Atlantic Ridge, is formed by nine volcanic isles divided in three groups: the eastern group (São Miguel, Santa Maria and Formigas Islets), the central group (Terceira, Graciosa, São Jorge, Pico and Faial) and the western group (Flores and Corvo). This paper is a follow-up of the study of diversity of corticoid fungi of three islands of the central group: Faial, Pico, and Terceira, recently published by Telleria et al. (2009). The present issue comprises the catalogue of species from Flores (western group) and São Miguel (eastern group).

Lying on the most westerly side of the group of islands, Flores has a surface of 143 km². It is located approximately 1890 km from the European continent and is situated at 39°28' N latitude and 31°13' W longitude. The place is characterized by deep valleys and peaks; Morro Alto is the highest peak of the island, reaching an altitude of 913 msl. São Miguel Island is the largest and most densely populated of the Azores archipelago and covers a surface of 750 km², it is located approximately 1350 km from the European continent and situated at 37°44' N latitude and 25°41' W longitude. Its relief is dominated by the Pico da Vara (1103 msl) in the eastern part and the Pico das Éguas (873 msl) in the west, the central part is the lowest (maximum of 400 msl).

The climate of the Azores is temperate oceanic, the mean annual temperatures is 14–18°C and the mean annual precipitation 740–3000 mm increasing from east to west. The highest level is on Flores where the mean annual precipitation at 500 msl is more than 2500 mm. The most humid period, between October and March, contributes 65–70% of the annual rainfall and the relative humidity exceeds 95% on more than 50 days per year.

The wildlife on Azores has been severely affected since the arrival of the first Portuguese settlers 500 year ago. The flora of vascular plants of Azores consists of 1002 taxa, 31% indigenous and 69% introduced. Flores has 55.2% of introduced taxa and São Miguel 66%. The majority of indigenous taxa have a wide distribution and of these more or less 60 are endemic (Silva & Smith, 2004). Four of them are predominating substrata of corticioid fungi, i.e. *Juniperus brevifolia* subsp. *azorica*, *Picconia azorica*, *Erica azorica* and *Ilex azorica*. The most important introduced substrata are: *Pittosporum undulatum*, *Cryptomeria japonica* and *Acacia melanoxylon*.

Until now, 101 species of corticioid fungi have been reported from Azores. The earlier information available about corticioid fungi is the following: Dennis et al. (1977) published a report from this archipelago; Dueñas et al. (2008) described *Candelabrochaete macaronesica* from Faial, and Melo et al. (2008) *Repetobasidium azoricum* from Terceira. Recently Telleria et al. (2009) have published a preliminary survey with 88 species.

Material and methods

Twenty-nine localities were surveyed over a period of ten days at the spring of 2007. All potential substrates, indigenous and introduced taxa were examined. 644 samples were studied following classical methods: thin, freehand sections were mounted in KOH (5%) and/or Melzer reagent and examined under Olympus BH 50 and Olympus BX 50 microscopes. The specimens have been deposited in BIO, LISU, MA-Fungi, and TFCMic. herbaria.

Results

The catalogue for the corticioid fungi from Flores and São Miguel (<http://www.mycotaxon.com/resources/weblist.html>.) includes so far 83 species, of which 32 are new to the archipelago. They belong to 37 genera. *Trechispora* (9 species), *Hyphodontia* (7 species), *Peniophora* (6 species), and *Tubulicium* (4 species) are the most significant genera. The following 32 species are new to Azores Archipelago: *Amyloenasma allantoporum* (Oberw.) Hjortstam & Ryvardeen, *Botryobasidium botryoideum* (Overh.) Parmasto, *B. obtusisporum* J.Erikss., *Cabalodontia subcretacea* (Litsch.) Piątek, *Cylindrobasidium eucalypti* (M.Dueñas & Tellería) Tellería & Melo, *C. torrendii* (Bres.) Hjortstam, *Dendrothele griseocana* (Bres.) Bourdot & Galzin, *Gloeocystidiellum clavuligerum* (Höhn. & Litsch.) Nakasone, *Hymenochaete fuliginosa* (Pers.) Lév., *H. rubiginosa* (Dicks.) Lév., *Hyphodontia abieticola* (Bourdot & Galzin) J.Erikss., *H. arguta* (Fr.) J.Erikss., *H. bugellensis* (Ces.) J.Erikss., *Litschauerella abietis* (Bourdot & Galzin) Oberw., *Peniophora bicornis* Hjortstam & Ryvardeen, *P. cinerea* (Pers.) Cooke, *Peniophorella tsugae* (Burt) K.H.Larss., *Phanerochaete sordida* (P.Karst.) J.Erikss. & Ryvardeen, *Phlebiella ardosiacae* (Bourdot & Galzin) K.H.Larss. & Hjortstam, *P. fibrillosa* (Hallenb.) K.H.Larss. & Hjortstam, *Scytinostromella nannfeldtii* (J.Erikss.) G.W.Freeman & R.H.Petersen, *Sistotrema brinkmannii* (Bres.) J.Erikss., *Subulicystidium longisporum* (Pat.) Parmasto, *S. nikau* (G.Cunn.) Jülich, *Trechispora caucasica* (Parmasto) Liberta, *Tr. cohaerens* (Schwein.) Jülich & Stalpers, *Tr. minima* K.H.Larss., *Tr. minuta* K.H.Larss., *Tr. subsphaerospora* (Litsch.) Liberta, *Tubulicium filicicola* (G.Cunn.) Oberw., *Tubulicrinis regificus* (H.S.Jacks. & Dearden) Donk, *Xenasma pruinosum* (Pat.) Donk.

Among the more frequent species are *Peniophorella praetermissa* (P.Karst.) K.H.Larss., *Peniophora lycii* (Pers.) Höhn. & Litsch., *Hymenochaete corrugata* (Fr.) Lév., *Tubulicium dussii* (Pat.) Oberw., *Amylostereum laevigatum* (Fr.) Boidin, *Aphanobasidium filicinum* (Bourdot) Jülich, *Hyphoderma transiens* (Bres.) Parmasto, *Hyphodontia nespori* (Bres.) J.Erikss. & Hjortstam, *Trechispora nivea* (Pers.) K.H.Larss., and *Tr. stellulata* (Bourdot & Galzin) Liberta. A remarkable finding is the presence in the archipelago of *Peniophora bicornis*, earlier recorded from Gabon, Réunion, Singapore, and Nepal (Boidin et al., 1991; Hjortstam & Ryvardeen, 2007).

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Literature cited

- Boidin J, Lanquetin P, Gilles G. 1991. Les *Peniophoraceae* de la zone intertropicale (*Basidiomycetes, Aphyllophorales*). A. Espèces paleotropicales. Bulletin de la Société Mycologique de France 107: 91-147.
- Dennis RGW, Reid DA, Spooner BM. 1977. The fungi of the Azores. Kew Bulletin 32(1): 85–136.
- Dueñas M, Telleria MT, Melo I, Rodríguez-Armas JL, Beltrán E. 2008. A new species of *Candelabrochaete* (*Polyporales, Basidiomycota*). Mycotaxon 103: 299–305.
- Hjortstam K, Ryvar den L. 2007. Checklist of corticioid fungi (*Basidiomycotina*) from tropics, subtropics and southern hemisphere. Synopsis Fungorum 22: 27–146.
- Melo I, Dueñas M, & Telleria MT. 2008. *Repetobasidium azoricum* (*Basidiomycotina, Sistotremaceae*), a new species from Azores Islands. Synopsis Fungorum 25: 6-10.
- Silva L, Smith CW. 2004. A characterization of the non-indigenous flora of the Azores Archipelago. Biological Invasions 6: 193-204.
- Telleria MT, Melo I, Dueñas M, Rodríguez-Armas JL, Beltrán-Tejera E, Cardoso J, Salcedo I. 2009. Diversity and richness of corticioid fungi (*Basidiomycota*) on Azores Islands: a preliminary survey. Nova Hedwigia 88: 285-308.

***Phyllactinia* and *Ovulariopsis* species on legumes**

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Abstract — Four new powdery mildew species belonging to tribe *Phyllactinieae* are described, illustrated, and discussed. These include *Phyllactinia erythrinae-americanae* based on Mexican material on *Erythrina americana*, *P. robiniae* occurring in North America on *Robinia neomexicana* and *R. pseudoacacia*, *Ovulariopsis erythrinae-abyssinicae* on *Erythrina abyssinica* in Zambia, and *O. leucaenae* on *Leucaena latisiliqua* in Honduras and Mexico. The South African *Phyllactinia erythrinae* is redescribed based on an examination of type material. Host ranges, distributions and the affinities of these new taxa to other species of *Phyllactinia* and *Ovulariopsis* on legumes, including *Phyllactinia fraxini* on *Wisteria sinensis* in Europe, are discussed, and a key to the species concerned is provided.

Key words — *Erysiphales*, *Fabaceae*, taxonomy

Introduction

Previously, *Phyllactinia guttata* (Wallr. : Fr.) Lév. was considered a plurivorous species complex on a wide range of hosts (Braun 1987). However, based on molecular sequence analyses (Takamatsu et al. 2008) and morphological differences in the shape and size of penicillate cells (Shin & Lee 2002), it was shown that a narrower species concept has to be applied within *Phyllactinia* Lév., i.e. the compound species *P. guttata* s. lat. has to be split into several species. Samples of *Phyllactinia* on *Erythrina americana* recently collected in Mexico led to a comparison with type material of *Phyllactinia erythrinae*, a taxon described from South Africa (Doidge 1948), and other *Phyllactinia* and *Ovulariopsis* spp. on legumes. The examination of all of this material revealed that the Mexican samples discussed above and several others discussed below represent new taxa. An *Ovulariopsis* Pat. & Har. anamorph on *Leucaena latisiliqua*, which has been found in Honduras and Mexico, proved to be a new species. The

new *Ovulariopsis* resembles the anamorph of a *Phyllactinia* on *Robinia* spp. in North America, which also proved to be an undescribed species. Furthermore, a collection of *Ovulariopsis* on *Erythrina abyssinica* from Zambia proved to be distinct from all anamorphs of *Phyllactinia* spp. on legumes. These new species have been compared with other *Phyllactinia* species described from the *Fabaceae*, and a key to *Phyllactinia* and *Ovulariopsis* species on hosts in this family has been prepared.

Materials and methods

The chasmothecia of the examined collections were described from material mounted in distilled water using oil immersion (bright field and phase contrast), but without any staining, using standard light microscopy (Olympus BX 50, Hamburg, Germany). Specimens of the anamorphs were put into a drop of lactic acid and gently heated. Conidia and other structures were measured ($\times 1000$ magnification, $n = 30$ for each structure) with the extremes given in parentheses. The new Mexican collections are deposited at the herbarium of the Martin-Luther-University, Institute of Biology, Geobotany, Halle (Saale), Germany (HAL) and the herbarium of the Colegio de Postgraduados, Campus Montecillo, Orientación Fitopatología, Montecillo, Texcoco, Edo. de Méx., Mexico (CMPH). Other examined collections are from the following herbaria: BPI, IMI and PREM (abbreviations according to Holmgren et al. 1990).

Taxonomy

(1) *Phyllactinia erythrinae* Doidge, Bothalia 4: 841, 1948

FIG. 1

MATERIAL EXAMINED: SOUTH AFRICA. Greytown, on living leaves of *Erythrina caffra* Thunb. (*Fabaceae*), 16 Feb. 1929, E.M. Doidge (PREM 15418, **holotype**).

MYCELIUM internal and external, superficial mycelium hypophyllous, effuse, forming dense white patches or covers, persistent. HYPHAE straight to somewhat flexuous, branched, usually at right angles, 3–7 μm wide, hyaline, septate, thin-walled, smooth. APPRESSORIA not seen. CONIDIOPHORES arising from superficial hyphae, erect, straight to flexuous-sinuous throughout, up to 180 μm long, foot-cells straight to flexuous, up to 110 μm long and 5–9 μm wide, followed by 1–3 cells of variable length, but mostly shorter than the foot-cells, basal septum up to 10(–15) μm distant from the branching point with the supporting hypha. CONIDIA solitary, uniformly clavate, 60–100 \times 15–25 μm , apex broadly rounded to somewhat attenuated. CHASMOTHECIA hypophyllous, scattered to gregarious, often immersed in the mycelial felt, 175–240 μm diam. PERIDIAL CELLS irregularly polygonal, 5–20 μm diam. PENICILLATE CELLS numerous, up to 80 μm long, stem subcylindrical to broadly ellipsoid-ovoid, 25–50 \times 10–20 μm , apex with two to several distinct branchlets, short cylindrical

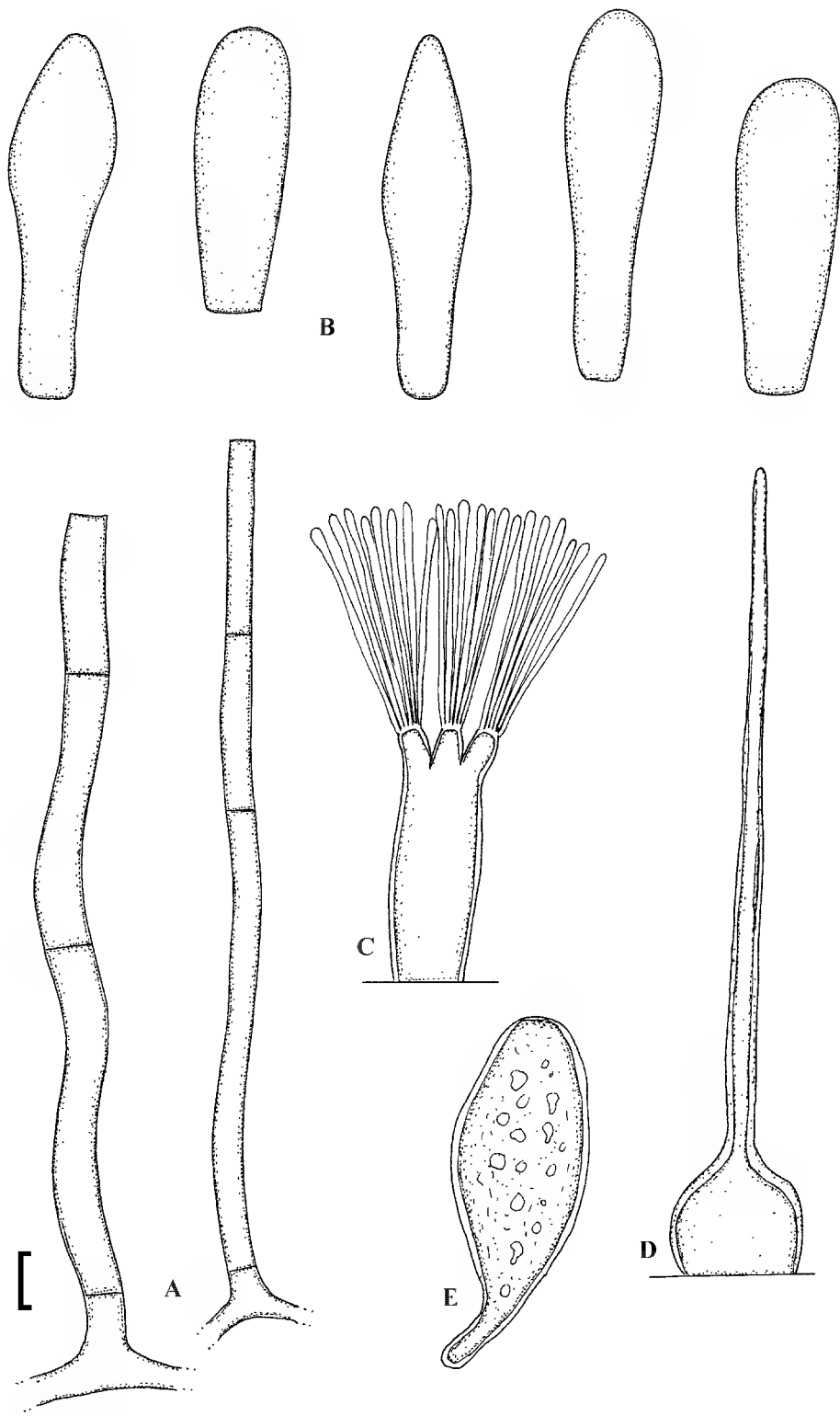


FIG. 1. *Phyllactinia erythrinae*.
A. Conidiophores. B. Conidia. C. Penicillate cell. D. Appendage. E. Ascus.
Scale bar = 10 μ m [based on holotype material]. U. Braun *del.*

to somewhat conical, filaments about as long as the stem. APPENDAGES more or less equatorial, 7–15, (1–)1.5–2 times as long as the chasmothecial diam. (up to 450 μ m long), bulbous base 30–45(–50) μ m diam., upper part acicular, apex obtuse to pointed, hyaline, wall thickened, up to 4 μ m. ASCI numerous, usually more than 15, narrowly saccate, stalked, 50–80 \times 25–35 μ m, always immature, ascospores not developed.

COMMENTS: *Phyllactinia erythrinae* was described on *Erythrina caffra* from South Africa (Doidge 1948). Braun (1987) reduced this species to synonymy with *P. guttata* s. lat., which is, however, not tenable due to obvious differences between *P. guttata* s. str. (Shin & Lee 2002) and *P. erythrinae*. The penicillate cells of the chasmothecia of the South African species are characterized by having few, distinct, oblong, terminal branchlets, and the conidiophores are flexuous-sinuuous. The stems of the penicillate cells in *P. guttata* s. str. have numerous [2–10(–16)], short, bulbous branchlets (Shin & Lee 2002), and the conidiophores are straight. The anamorph of *P. erythrinae* was not described in detail by Doidge (1948).

(2) *Phyllactinia erythrinae-americanae* Yáñez-Morales & U. Braun, sp. nov.

MYCOBANK MB 513302.

FIG. 2

Phyllactinia erythrinae similis, sed hyphis valde flexuosis-sinuosis vel irregularibus, septo basali conidiophori 5–10 µm semoto a ramificatione mycelii, usque ad 10–35 µm, conidiis distincte dimorphis, conidiis primariis lanceolatis, 60–80 × 15–23 µm, conidiis secundariis clavatis, 50–90 × 18–26 µm, chasmotheciis parvioribus, (140–)150–200 µm diam., et appendicibus minoribus, 4–10.

TYPE: MEXICO. EDO. DE MEXICO, Texcoco, on living leaves of *Erythrina americana* Mill. (*Fabaceae*), 2 Nov. 2008, Ma. de Jesús Yáñez-Morales (HAL 2316 F, holotype; isotype, CMPH).

MYCELIUM internal and external, superficial mycelium hypophyllous, forming thin white to grayish white patches or covers. HYPHAE straight to usually strongly flexuous-sinuuous to irregularly shaped, branched, 3–10 µm wide, septate, hyaline, smooth, thin-walled. APPRESSORIA solitary, nipple-shaped, elongated, hooked to usually strongly lobed, almost coralloid, 4–15 µm diam. CONIDIOPHORES solitary per hyphal cell, erect, 50–170 µm long, foot-cells 30–130 × 6–9 µm, straight, cylindrical to flexuous-sinuuous, basal septum always distant (10–35 µm) from the branching point with the supporting hypha, curved to sinuous part mostly confined to the portion below the basal septum, foot-cells followed by 1–2 shorter cells, 15–40 µm long. CONIDIA formed singly, dimorphic, primary conidia lanceolate, attenuated towards the tip, obtuse to pointed, base rounded to subtruncate, 60–80 × 15–23 µm, secondary conidia clavate, apex rounded, base subtruncate, 50–90 × 18–26 µm, germ tubes subapical or near the base, rarely lateral, flexuous, short to long, long germ tubes with septum. CHASMOTHECIA scattered to subgregarious, (140–)150–200 µm diam. PERIDIAL CELLS irregularly polygonal, 5–20 µm diam. PENICILLATE CELLS numerous, stem subcylindrical, 30–60 × (8–)10–15(–18) µm, apex with two to several distinct branchlets, sometimes deeply cleft, up to 25 µm, filaments about as long as the stem. APPENDAGES more or less equatorial, 4–10, 1–2 times as long as the chasmothecial diam. (80–325 µm long), bulbous base 25–45 µm diam., upper part acicular, apex pointed, hyaline, wall thickened, up to 4 µm. ASCI not developed.

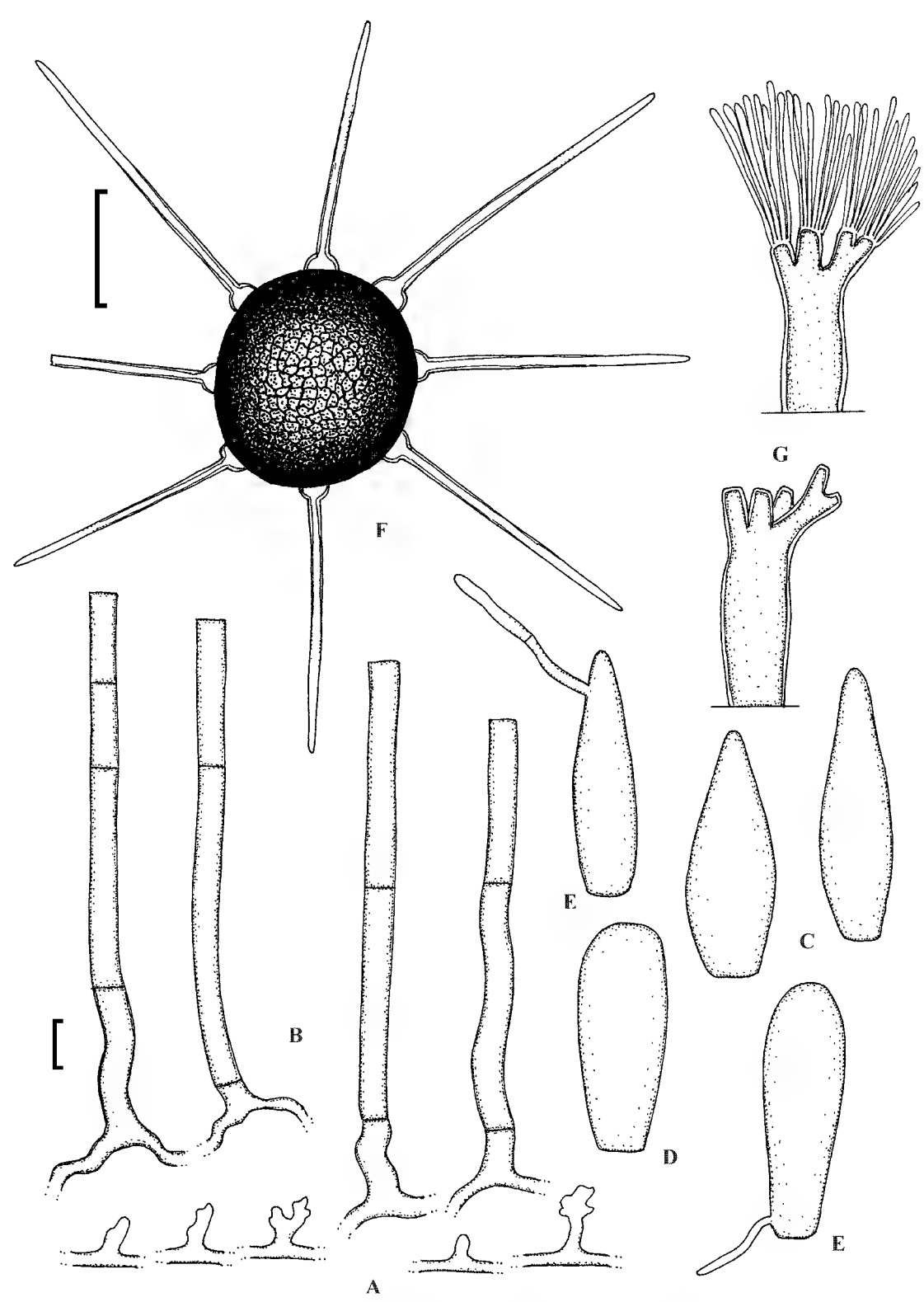


FIG. 2. *Phyllactinia erythrinae-americanae*.
A. Appressoria. B. Conidiophores. C. Primary conidia. D. Secondary conidium.
E. Conidia with germ tubes. F. Chasmothecium. G. Penicillate cells.
Scale bars = 10 μm (A–E, G), 100 μm (F) [based on holotype material]. U. Braun *del.*

ADDITIONAL MATERIAL EXAMINED: MEXICO. EDO. DE MEXICO, Universidad Autónoma Chapingo, on living leaves of *Erythrina americana*, 8 Oct. 2008, J.M. López Pedraza (HAL 2314 F, CMPH, paratypes). MEXICO, DISTRITO FEDERAL, Delegación Coyoacán, on living leaves of *Erythrina americana*, 15 Oct. 2008, J.M. López-Pedraza (HAL 2315 F, CMPH, paratypes).

COMMENTS: Mexican material on *Erythrina americana* has been compared with type material of *Phyllactinia erythrinae*. The Mexican *Phyllactinia* on *Erythrina americana* is morphologically close to the South African *P. erythrinae*, but the latter species is easily distinguishable by having straight to only slightly flexuous hyphae, uniformly clavate conidia, $60\text{--}100 \times 15\text{--}25\ \mu\text{m}$, and larger chasmothecia with (7–)9–15 appendages. Furthermore, the conidiophores are straight to flexuous-sinuuous throughout, with a basal septum up to $10\text{--}15\ \mu\text{m}$ distant from the branching point with the supporting hypha. Mazzanti de Castañón & Cabrera de Alvarez (1985) described and illustrated *Phyllactinia* sp. on *Erythrina crista-galli* L. and *E. dominguezii* Hassl. from Argentina. Due to conidiophores with twisted foot-cells, dimorphic conidia (lanceolate and clavate) and penicillate cells with distinct terminal branchlets, these collections agree well with the Mexican material and seem to be close to or maybe identical with *P. erythrinae-americanae*. However, Mazzanti de Castañón & Cabrera de Alvarez (1985) described somewhat larger chasmothecia (up to $229\ \mu\text{m}$ diam.) with 10–22 appendages. All collections on *Erythrina*, i.e. from Argentina, Mexico, and South Africa, are characterized by lacking or immature asci, which seems to be a characteristic, basic feature for this group of *Phyllactinia* species. The flexuous conidiophore foot-cells of *P. erythrinae-americanae* resemble those of *Phyllactinia dalbergiae* Piroz. (Braun 1987), but the latter species differs in having uniformly clavate conidia. Lanceolate conidia are also known in the South African *P. cassiae* G.J.M. Gorter & Eicker (Gorter & Eicker 1987), which is, however, easily distinguishable from *P. erythrinae-americanae* by having conidiophores with uniformly straight foot-cells and a basal septum only $5\text{--}10\ \mu\text{m}$ distant from the branching point with the supporting hypha. Additionally, clavate conidia are lacking.

(3) *Phyllactinia robiniae* U. Braun & Yáñez-Morales, sp. nov.

FIG. 3

MYCOBANK MB 513303.

Phyllactinia erythrinae-americanae similis, sed chasmotheciis majoribus, (180–)200–260 μm diam., et appendicibus brevioribus, 170–220 μm longis, septo primario conidiophori plus minusve basali, cellulis basalibus ubique sinuosis-subhelicoidibus.

TYPE: USA. ARIZONA, Maricopa County, Wickenburg, Hossayampa Lake Road, on living leaves of *Robinia neomexicana* A. Gray (*Fabaceae*), 22 Aug. 1958, P.D. Keener (BPI 606711, holotype).

MYCELIUM internal and external, superficial mycelium hypophyllous, forming white patches or covers, persistent. HYPHAE straight to usually strongly flexuous-sinuuous, branched, $2\text{--}6\ \mu\text{m}$ wide, hyaline, thin-walled, smooth. APPRESSORIA solitary, nipple-shaped, oblong, straight to slightly curved, occasionally slightly lobed, $3\text{--}7\ \mu\text{m}$ diam. or up to $10\ \mu\text{m}$ long. CONIDIOPHORES arising from superficial hyphae, erect, $70\text{--}130\ \mu\text{m}$ long, foot-cells up to $80\ \mu\text{m}$ long, $2\text{--}7\ \mu\text{m}$ wide, flexuous, sinuous-subhelicoid, first septum at the base or only up to

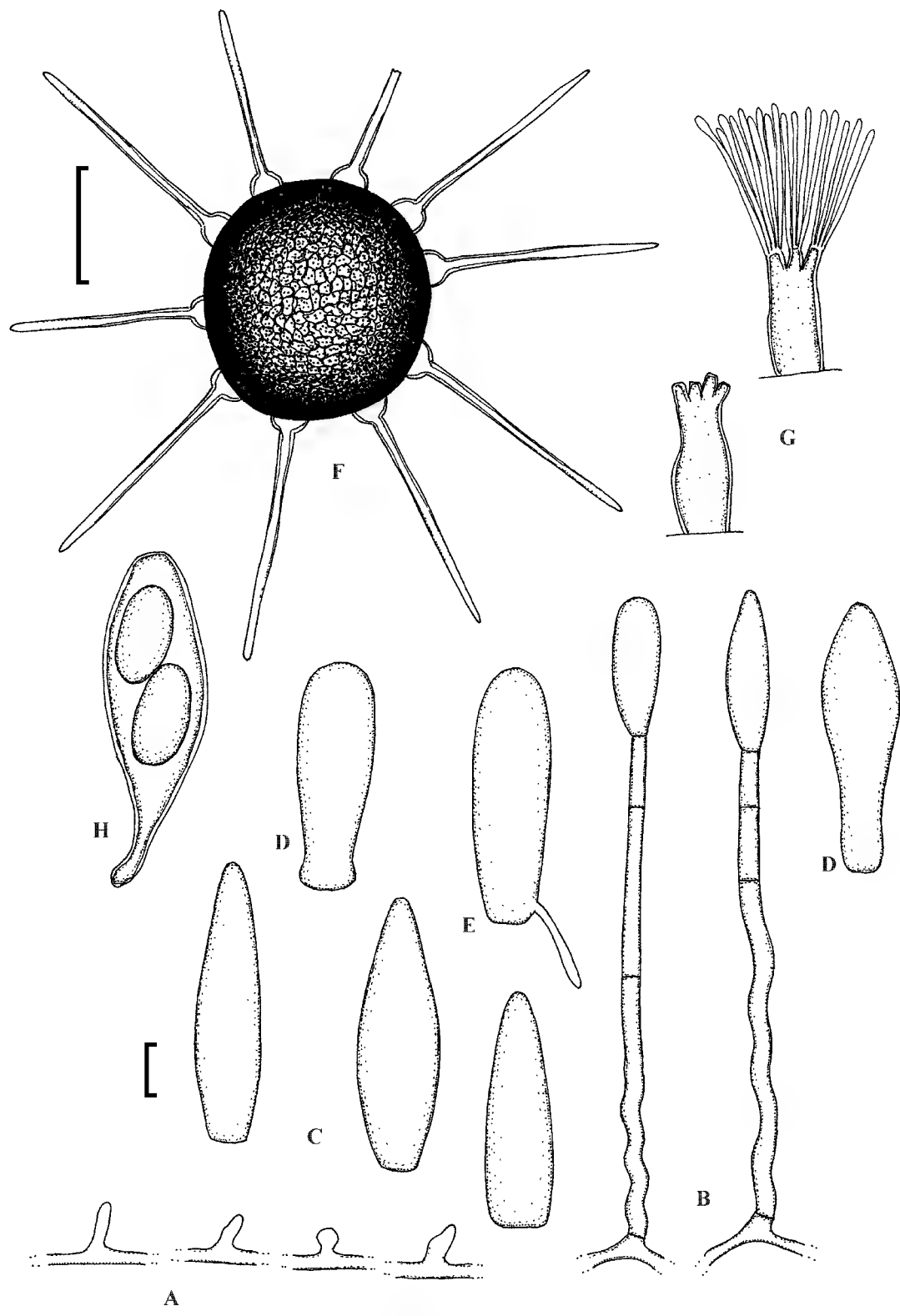


FIG. 3. *Phyllactinia robiniae*.
A. Appressoria. B. Conidiophores. C. Primary conidia. D. Secondary conidia.
E. Conidium with germ tubes. F. Chasmothecium. G. Penicillate cells. H. Ascus.
Scale bars = 10 μ m (A–E, G–H), 100 μ m (F) [based on holotype material]. U. Braun *del.*

5 μ m distant from the branching point with the supporting hypha, foot-cells followed by 1–2 shorter cells, 10–40 μ m long. CONIDIA solitary, primary conidia lanceolate, attenuated towards the tip, 40–55 \times 12–18 μ m, secondary conidia clavate, 40–70 \times (10–)12–22 μ m (on average wider than 15 μ m), occasionally

somewhat enlarged at the very base, germ tubes subapical or subbasal, moderately long, simple or with a slightly lobed terminal appressorium. CHASMOTHECIA hypophyllous, scattered to subgregarious, (180–)200–260 μm diam. PERIDIAL CELLS irregularly polygonal, 10–25 μm diam. PENICILLATE CELLS terminal, numerous, up to 100 μm long, stem subcylindrical to ampulliform, 25–50 \times 8–18 μm , with several short terminal branchlets, subcylindrical to bulbous, filaments 20–60 μm long. Appendages more or less equatorial, 10–18, short, 0.6–1.2 times as long as the chasmothecial diam. (170–220 μm), bulbous base 25–45 μm diam., upper part acicular, apex pointed, hyaline, wall thickened, up to 3 μm . ASCI numerous, usually more than 20, clavate-saccate, 60–90 \times 25–35(–40) μm , thin-walled (ca. 1 μm wide), 2-spored. ASCOSPORES broadly ellipsoid-ovoid, hyaline, 20–35 \times 10–23 μm .

ADDITIONAL MATERIAL EXAMINED: USA. ARIZONA, near Jerome, Mingus Mts., on living leaves of *Robinia neomexicana*, 13 Oct. 1917, L.N. Gooding (BPI 606716). ARIZONA, Prescott, on living leaves of *Robinia neomexicana*, 14 Sep. 1919, W.H. Long (BPI 60713, paratype). ARIZONA, Santa Catalina Mts., Mt. Lemmon, on living leaves of *Robinia neomexicana*, 13 Nov. 1948, W.G. & R. Solheim, Mycoflora Saximontanensis Exsiccata 416 (BPI 606710, paratype). ARIZONA, Yavapai County, Senator Mountain Highway, near Groom Creek, on living leaves of *Robinia neomexicana*, 22 Apr. 1958, P.D. Keener (BPI 606712, paratype). NEW MEXICO, Santa Fe National Forest, Eureka Lodge, on living leaves of *Robinia neomexicana*, 26 Sep. 1937, W.H. Long (BPI 606714, paratype). NEW MEXICO, Santa Fe, 28 Aug. 1938, W.H. Long (BPI 606715). NEW MEXICO, State College, on living leaves of *Robinia pseudoacacia* L. (*Fabaceae*), Oct. 1936, I.H. Crowell (BPI 607138, paratype).

COMMENTS: This new *Phyllactinia* on *Robinia* spp. resembles *P. erythrinae-americanae*. However, the basal septum of the conidiophores in the latter species is 10–35 μm distant from the branching point with the supporting hypha, and the sinuous part is usually confined to the portion below the basal septum. Furthermore, the chasmothecia in *P. erythrinae-americanae* are much smaller, (140–)150–200 μm diam., and have less appendages (4–10). In *P. dalbergiae*, another species with twisted foot-cells of the conidiophores, the conidia are uniformly clavate, i.e. lanceolate conidia are lacking (Braun 1987).

(4) *Ovulariopsis erythrinae-abyssinicae* U. Braun & Yáñez-Morales, sp. nov.

MYCOBANK MB 513304.

FIG. 4

Mycelium internum et externum, mycelium externum hypophyllum, gracile, albidum, evanescens, hyphis ramosis, septatis, hyalinis, tenuitunicatis, laevibus, 2–6 μm latis. Appressoria ignota. Conidiophora solitaria, ex hyphis superficialibus oriunda, erecta, recta, subcylindrica, usque ad 220 μm longa, recta, septo basali 5–10 μm semoto a ramificatione mycelii, cellulis basalibus usque ad 90 μm longis et 6–9 μm latis, rectis, interdum basi leniter curvata vel flexuosa, cellulis sequentibus 1–2, 15–50 μm longis. Conidia solitaria, late clavata-obovoidea, (35–)40–60 \times 18–28 μm .

TYPE: ZAMBIA. 9 miles west of Lusaka, on living leaves of *Erythrina abyssinica* Lam. ex DC. [= *E. tomentosa* R. Br. ex A. Rich.] (*Fabaceae*), 6 Apr. 1962, A. Angus (IMI 95369a, holotype).

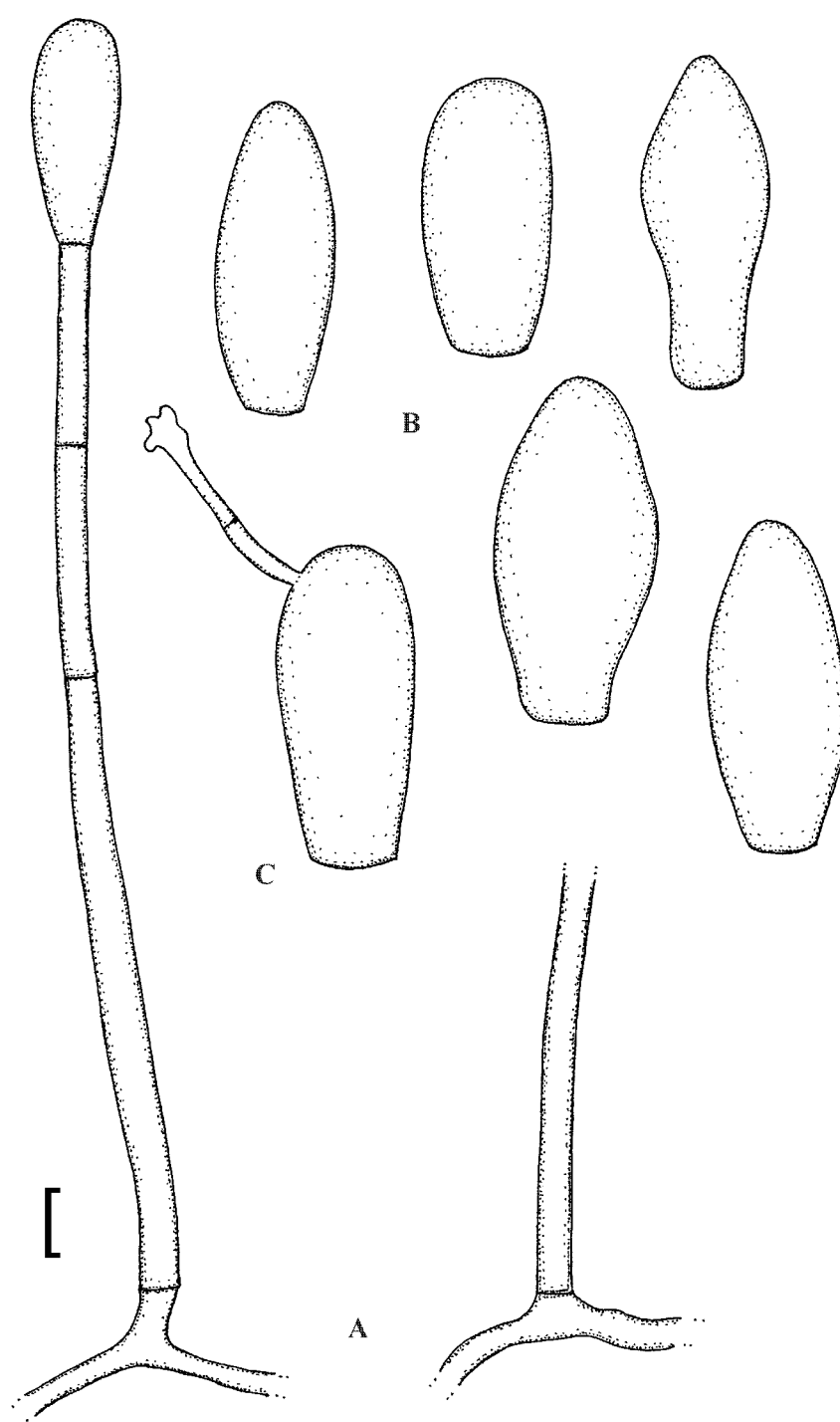


FIG. 4. *Ovulariopsis erythrinae-abyssinicae*.
 A. Conidiophores. B. Conidia. C. Conidium with germ tubes.
 Scale bar = 10 μm [based on holotype material]. U. Braun *del.*

MYCELIUM internal and external, external mycelium hypophyllous, thin, evanescent. HYPHAE branched, septate, hyaline, thin-walled, smooth, 2–6 μm wide. APPRESSORIA not seen. CONIDIOPHORES arising from superficial hyphae, erect, straight, cylindrical, up to 220 μm long, basal septum 5–10 μm distant from the branching point with the supporting hypha, foot-cells up to 90 μm long, 6–9 μm wide, straight, occasionally slightly curved to flexuous at the very base, followed by 1–2 shorter cells, 15–50 μm long. CONIDIA formed singly, broadly clavate-obovoid, (35–)40–60 \times 18–28 μm .

COMMENTS: This *Ovulariopsis* on *Erythrina abyssinica* from Africa is easily distinguishable from the anamorph of *P. erythrinae* by its much shorter, broadly clavate-obovoid conidia (conidia oblong clavate, $60\text{--}90(-100) \times 15\text{--}25\ \mu\text{m}$ in *P. erythrinae*) and straight conidiophores. The anamorph of *Phyllactinia erythrinae-americanae* differs in having distinctly dimorphic conidia and conidiophores with a basal septum up to $35\ \mu\text{m}$ distant from the branching point with the supporting hypha. Furthermore, the foot-cells of the conidiophores are often flexuous-sinuuous, especially at the base below the septum.

(5) *Ovulariopsis leucaenae* López-Pedraza, Yáñez-Morales & U. Braun, sp. nov.

MYCOBANK MB 513305.

FIG. 5

Oidio Phyllactiniae robiniae valde simile, sed conidiis angustioribus, conidiis primariis $40\text{--}60 \times 8\text{--}13\ \mu\text{m}$, conidiis secundariis $40\text{--}65 \times 10\text{--}15\ \mu\text{m}$.

TYPE: MEXICO. Guerrero, Alpoeyca, Municipality of Huamuxtitlan, on living leaves of *Leucaena latisiliqua* (L.) Gillis [= *L. leucocephala* (Lam.) de Wit] (Fabaceae), 10 Jan. 2009, J.M. López-Pedraza (HAL 2318 F, holotype; isotype, CMPH).

MYCELIUM internal and external, amphigenous, forming thin, white or grayish white epiphyllous covers and small hypophyllous patches. HYPHAE usually flexuous, irregular, geniculate-sinuuous, subtorulose, branched, $3\text{--}8\ \mu\text{m}$ wide, hyaline, thin-walled, smooth. APPRESSORIA solitary, rarely in opposite pairs, nipple-shaped, oblong, hooked to distinctly lobed, $3\text{--}8\ \mu\text{m}$ diam. CONIDIOPHORES arising from superficial hyphae, solitary, position between two hyphal septa usually non-central, erect, $40\text{--}180 \times 2\text{--}7.5\ \mu\text{m}$, basal septum mostly somewhat distant from the branching point with the supporting hypha, ca. $5\ \mu\text{m}$, foot-cells $25\text{--}110 \times 2\text{--}6\ \mu\text{m}$, flexuous-sinuuous, subhelicoid, usually followed by 1–2(–3) shorter cells, $15\text{--}40\ \mu\text{m}$ long, occasionally second cell relatively long, conidiogenous cell sometimes distinctly bent before the conidial secession. CONIDIA solitary, dimorphic, primary conidia narrowly ellipsoid-obovoid to distinctly lanceolate, rarely subcylindrical, apex rounded to somewhat pointed, base subtruncate, $40\text{--}60 \times 8\text{--}13\ \mu\text{m}$, secondary conidia distinctly clavate, $50\text{--}70 \times 10\text{--}15\ \mu\text{m}$, apex broadly rounded, base subtruncate, germ tubes subbasal, filiform, short to moderately long, straight to sinuous.

ADDITIONAL MATERIAL EXAMINED: HONDURAS. Taulabe, on living leaves of *Leucaena latisiliqua*, 2 Feb. 1993, E. Boa & J. Lenne (IMI 35936, paratype).

COMMENTS: *O. leucaenae* is morphologically close to *Phyllactinia robiniae*, but it differs in having much narrower conidia, on average narrower than $15\ \mu\text{m}$. Furthermore, the conidiophores of *O. leucaenae* with flexuous-sinuuous to subhelicoid foot-cells resemble those of *Phyllactinia dalbergiae*, but the latter species is easily distinguishable from the *Ovulariopsis* on *Leucaena* by having broader, uniformly clavate conidia, $(10\text{--})13\text{--}24\ \mu\text{m}$ wide (Braun 1987, Bappammal 1995, Paul & Thakur 2006). The conidiophores of *P. erythrinae-*

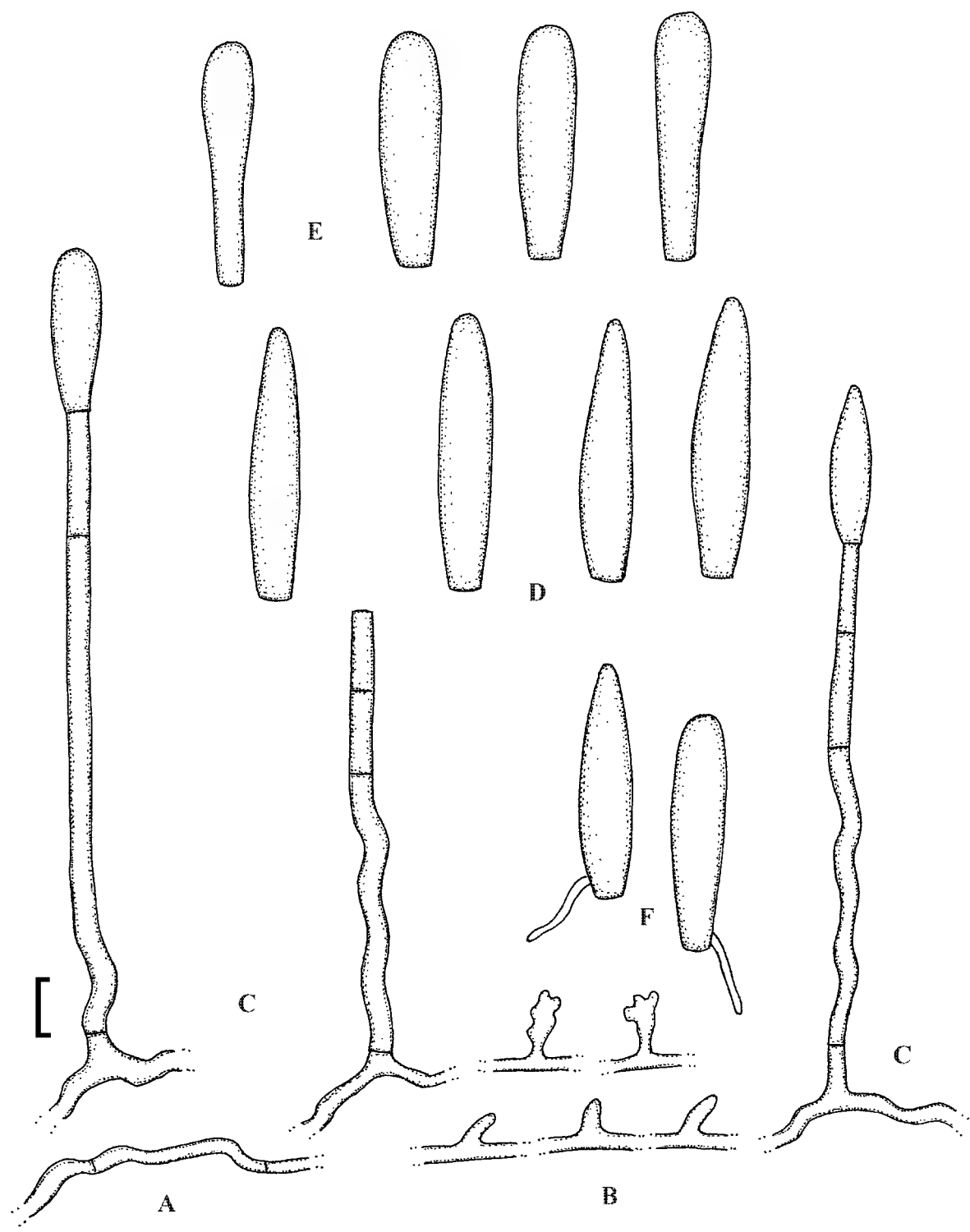


FIG. 5. *Ovulariopsis leucaenae*.
A. Hypha. B. Appressoria. C. Conidiophores.
D. Primary conidia. E. Secondary conidia. F. Conidia with germ tubes.
Scale bar = 10 μ m [based on holotype material]. U. Braun *del.*

americanae are also similar, but broader, 6–9 μ m wide, and mostly only flexuous-sinuuous below the basal septum, which is up to 35 μ m distant from the branching point with the supporting hypha. Additionally, the conidia of the latter species are much wider, 15–23 μ m. *P. cassiae* is another *Phyllactinia* species on a legume with lanceolate conidia, but clavate conidia are lacking.

Also, the foot-cells of the conidiophores are straight, and the conidia are wider, (12.5–)15–17.5(–20) μm .

Key to *Phyllactinia* and *Ovulariopsis* spp. on legumes

Several other species of *Phyllactinia* and *Ovulariopsis* have been described from hosts belonging to the *Fabaceae*: *Ovulariopsis ellipsospora* G.J.M. Gorter (Gorter 1989), *Phyllactinia acaciae* Syd. (Sydow 1935, Doidge 1948, Patil 1962) [holotype material examined (PREM 23428)], *P. adesmiae* Havryl. (Havrylenko 1995, 1997) [type material examined (HAL 1664 F)], *P. bauhiniae* Y.S. Paul (Paul & Thakur 2006, Braun & Paul 2009), *P. caesalpiniae* Y.N. Yu (Yu et al. 1979, Chen et al. 1987), *P. cassiae* (Gorter & Eicker 1987), *P. cassiae-fistulae* U. Braun & Y.S. Paul (Braun & Paul 2009), *P. dalbergiae* (Patil 1962, Pirozynski 1965, Braun 1987, Bappammal et al. 1995), *P. desmodii* J.F. Tao et al. (Tao et al. 1980), *P. erythrinae* (Doidge 1948), *P. evansii* Doidge (Doidge 1948) [holotype material examined (PREM 9758)], *P. phaseolina* N. Ahmad et al. (Ahmad et al. 1987), *P. sphenostylidis* Doidge (Doidge 1948) [holotype material examined (PREM 17024)], *P. verruculosa* D.Z. Xie (Xie 1992).

Phyllactinia suffulta f. *glycines* Jacz. (Jaczewski 1927) was introduced for a *Phyllactinia* on *Wisteria sinensis* (*Fabaceae*) recorded from Western Europe. A collection on this host has also been found in Germany (Sachsen-Anhalt, Halle, Botanical Garden of the Martin-Luther-University, 28 Oct. 1999, U. Braun, HAL 610 F). Takamatsu et al. (2008) included the *Phyllactinia* on *Wisteria sinensis* in molecular sequence analyses. Sequences of the latter fungus agreed with those of European collections of *Phyllactinia fraxini* (DC.) Fuss on *Fraxinus excelsior* (*Oleaceae*). The German collection on *W. sinensis* is characterized by having straight, filiform conidiophores, up to $100 \times 5\text{--}7 \mu\text{m}$, and uniformly clavate conidia, $50\text{--}70 \times 12\text{--}20 \mu\text{m}$. The chasmothecia are relatively large, $190\text{--}250 \mu\text{m}$ diam., with 6–15 appendages, 1–1.5 times as long as the chasmothecial diam., penicillate cells $60\text{--}90(100) \mu\text{m}$ long, stem subcylindrical to more or less ampulliform, $20\text{--}50 \mu\text{m}$ long, $10\text{--}25 \mu\text{m}$ wide, upper part narrower, $8\text{--}15 \mu\text{m}$, apex with several short to moderately long branchlets, up to $10 \mu\text{m}$ long, filaments about as long as the stem, $30\text{--}50 \mu\text{m}$, asci numerous, saccate, stalked, $50\text{--}90 \times 25\text{--}35 \mu\text{m}$, immature, a few 2-spored, ascospores $18\text{--}25 \times 12\text{--}15 \mu\text{m}$. Collections of *P. fraxini* found on *Syringa vulgaris* (*Oleaceae*) in the Botanical Garden Halle (HAL 609 F) and on planted trees of *Fraxinus excelsior* in the close neighborhood of the Botanical Garden Halle (U. Braun, Fungi selecti exsiccati 78, HAL) have been examined and compared with the *Phyllactinia* on *Wisteria sinensis*. Besides the genetic conformity, collections on *Fraxinus*, *Syringa* and *Wisteria* also coincide morphologically. This indicates that host switches within *Phyllactinia* have to be taken into consideration.

- 1 Chasmothecia and anamorph present or only anamorph present 2
- 1* Only chasmothecia present, anamorph lacking or unknown 15
- 2 Conidia uniform, clavate or broadly clavate-obovoid 3
- 2* Conidia either uniform, but not clavate, or distinctly dimorphic 7
- 3 Conidia broadly clavate-obovoid, $35\text{--}60 \times 18\text{--}28 \mu\text{m}$; conidiophores straight;
on *Erythrina abyssinica*, Zambia *Ovulariopsis erythrinae-abyssinicae*
- 3* Conidia uniformly clavate, usually longer and slender 4
- 4 Foot-cells of the conidiophores sinuous–twisted at the base;
on *Dalbergia* spp., Asia (India) *P. dalbergiae*
- 4* Foot-cells of the conidiophores straight or straight to flexuous throughout 5
- 5 Appendages less than 10 per chasmothecium, about as long as the chasmo-
thecial diam.; on *Sphenostylis angustifolia*, South Africa *P. sphenostylidis*
- 5* Appendages up to 15 per chasmothecium, 1–2 times as long as the chasmo-
thecial diam.; on other hosts 6
- 6 Asci always immature; conidiophores straight to flexuous throughout;
on *Erythrina caffra*, South Africa *P. erythrinae*
- 6* Asci usually developed and mature, with 2–3 ascospores; conidiophores straight;
on *Fraxinus* spp. and other hosts of the *Oleaceae*, in Europe occasionally
on *Wisteria sinensis* *P. fraxini*
- 7(2) Conidia uniformly ellipsoid-cylindrical, oblong, sometimes with somewhat
swollen ends 8
- 7* Conidia not ellipsoid-cylindrical or conidia distinctly dimorphic 12
- 8 Conidia often somewhat enlarged at the base, cingulum-like; on *Adesmia*
campestris, South America (Argentina) *P. adesmiae*
- 8* Conidia without cingulum-like structures 9
- 9 Conidia subcylindrical, but often somewhat concave in the middle,
 $10\text{--}15 \mu\text{m}$ wide at the ends and $6\text{--}9 \mu\text{m}$ wide in the middle; on *Acacia* spp.,
Asia, South Africa *P. acaciae*
- 9* Conidia ellipsoid-cylindrical, not concave in the middle (or with some old
conidia becoming narrower in the middle and wider at the ends, but then
cylindrical conidia wider, up to $18 \mu\text{m}$) 10
- 10 Conidia ellipsoid to narrowly ellipsoid-oblong, occasionally navicular
(almost clavate, but apex attenuated, pointed), $40\text{--}80 \times 17.5\text{--}27.5 \mu\text{m}$;
on *Cajanus cajan*, South Africa *Ovulariopsis ellipsospora*
- 10* Conidia ellipsoid-cylindrical, but not navicular, smaller, above all narrower,
ca. $40\text{--}60 \times 10\text{--}20 \mu\text{m}$ 11
- 11 Chasmothecia small, $150\text{--}180 \mu\text{m}$ diam., with 8–12 appendages; conidia
ellipsoid-cylindrical, $40\text{--}50 \times 10\text{--}20 \mu\text{m}$; on *Cassia fistula*,
Asia (India) *P. cassiae-fistulae*
- 11* Chasmothecia larger, $180\text{--}230 \mu\text{m}$ diam., with 10–15 appendages; conidia
subcylindrical, oblong, occasionally width slightly increasing towards the apex
(subclavate), $40\text{--}60 \times 10\text{--}18 \mu\text{m}$, some older conidia narrower in the middle, $7\text{--}9$
 μm , and wider at the ends; on *Burkea africana*, South Africa *P. evansii*

- 12(7) Conidiophores with straight foot-cells; conidia ventricose-lanceolate, tapering towards a pointed apex, finally becoming lageniform, with obtuse apex; on *Cassia abbreviata*, South Africa *P. cassiae*
- 12* Conidiophores at least partly flexuous-sinuous; conidia distinctly dimorphic, lanceolate and clavate 13
- 13 Foot-cells of the conidiophores straight to flexuous-sinuous at the base, basal septum 10–35 μm distant from the branching point with the supporting hypha, flexuous-sinuous portion usually confined to the part below the basal septum; conidia 50–90 \times 15–26 μm ; on *Erythrina americana*, Mexico *P. erythrinae-americanae*
- 13* Foot-cells of the conidiophores flexuous-sinuous to subhelicoid throughout, first septum of the conidiophores basal or only 5–10 μm distant from the branching point with the supporting hypha; conidia somewhat shorter 14
- 14 Conidia very narrow, 40–70 \times 8–15 μm ; on *Leucaena latisiliqua*, North America (Mexico, Honduras) *Ovulariopsis leucaenae*
- 14* Conidia on average wider than 15 μm ; on *Robinia* spp., North America *P. robiniae*
- 15(1) Chasmothecia large, 200–330 μm diam., appendages 5–16, long, (1–)1.5–2(–2.5) times as long as the chasmothecial diam.; on *Desmodium sinuatum*, China *Phyllactinia desmodii*
- 15* Chasmothecia smaller, diameter \leq 250 μm , appendages mostly shorter 16
- 16 Chasmothecia small, 150–190 μm diam., average < 180 μm , appendages about as long as the chasmothecial diam.; on *Cassia* spp. 17
- 16* Chasmothecia larger, average > 180 μm , or appendages longer; on other hosts ... 18
- 17 On *Cassia abbreviata*, South Africa *P. cassiae*
- 17* On *Cassia fistula*, India (distinct from *P. cassiae* in the anamorph) *P. cassiae-fistulae*
- 18 Asci always lacking, not developed or immature, even in mature chasmothecia, appendages 1–2 times as long as the chasmothecial diam.; on *Erythrina* spp. 19
- 18* Asci developed in mature chasmothecia or appendages shorter 20
- 19 Chasmothecia 180–240 μm diam., with 9–15 appendages; South Africa *P. erythrinae*
- 19* Chasmothecia (140–)150–200 μm diam., with 4–10 appendages; Mexico *P. erythrinae-americanae*
- 20 Appendages occasionally nodulose, surface irregular, coarsely verrucose, tips rounded, rarely uncinata; on *Indigofera scabrida*, China *P. verruculosa*
- 20* Appendages non-nodulose, smooth 21
- 21 Appendages about as long as the chasmothecial diam. or usually shorter 22
- 21* Appendages 1–1.5(–2) times as long as the chasmothecial diam. 24
- 22 Asci 2–3-spored; on *Acacia* spp., Asia (India), South Africa *P. acaciae*
- 22* Asci 2-spored; on other hosts 23

23*	Appendages 6–8; on <i>Bauhinia</i> sp., India	<i>P. bauhiniae</i>
23*	Appendages 10–18; on <i>Robinia</i> spp., North America	<i>P. robiniae</i>
24(21)	Ascospores very large, 43–64 × 16–22 µm; on <i>Adesmia campestris</i> , Argentina	<i>P. adesmiae</i>
24*	Ascospores smaller, length below 40 µm	25
25	Appendages 1–1.5(–2) times as long as the chasmothecial diam.	26
25*	Appendages about as long as the chasmothecial diam or shorter	27
26	Chasmothecia 190–250 µm diam., average > 200 µm, penicillate cells mostly ampulliform, wider at the base and narrower upwards, apically distinctly branched; occasionally on <i>Wisteria sinensis</i> , Europe	<i>P. fraxini</i>
26*	Chasmothecia smaller, 165–230 µm diam., average < 200 µm, penicillate cells narrowly cylindrical, not distinctly branched; on <i>Caesalpinia japonica</i> , <i>C. sepiaria</i> and <i>Gleditsia sinensis</i> (= <i>G. macracantha</i>), Asia	<i>P. caesalpiniae</i>
27	Appendages few, 4–10	28
27*	Appendages numerous, 6–20, usually more than 10	29
28	On <i>Sphenostylis angustifolia</i> , South Africa	<i>P. sphenostylidis</i>
28*	On <i>Phaseolus trilobus</i> , India	<i>P. phaseolina</i>
29	Asci very numerous, up to 40, 2–3-spored; on <i>Burkea africana</i> , South Africa	<i>P. evansii</i>
29*	Asci less numerous, usually 4–15, 2-spored; on <i>Dalbergia</i> spp., Asia	<i>P. dalbergiae</i>

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Literature cited.

- Ahmad N, Agarwal DK, Sarbhoy AK. 1987. Three new powdery mildews from northern India (*Ascomycotina* – *Erysiphaceae*). *Mycotaxon* 29: 67–72.
- Bappammal M, Hosagoudar VB, Udaiyan K. 1995. Powdery mildews of Tamil Nadu, India. *New Botanist* 22: 81–175.
- Braun U. 1987. A monograph of the *Erysiphales* (powdery mildews). *Beiheft zur Nova Hedwigia* 89: 1–700.
- Braun U, Paul YS. 2009. The Indian *Erysiphaceae* revisited. *Nova Hedwigia*, in press.
- Chen GQ, Han SJ, Lai YQ, Yu YN, Zheng RY, Zhao ZY. 1987: *Flora Fungorum Sinicorum*, Vol. 1, *Erysiphales*. Science Press, Beijing.

- Doidge EM. 1948. South African Ascomycetes in the National Herbarium, Part VI. *Bothalia* 4: 837–880.
- Gorter GJMA. 1989. *Ovulariopsis ellipsospora* sp. nov. (*Erysiphaceae*), a new powdery mildew fungus from pigeon pea, *Cajanus cajan*. *South African Journal of Botany* 55(3): 337–339.
- Gorter GJMA, Eicker A. 1987. Additional first records of perfect stages of powdery mildew fungi in South Africa, including a new species. *South African Journal of Botany* 53(1): 93–97.
- Havrylenko M. 1995. New records of *Erysiphaceae* from North-Patagonia (Argentina). *Nova Hedwigia* 61(3–4): 447–455.
- Havrylenko M. 1997. *Erysiphales* de la Region Andino-Patagonica. Thesis, Centro Regional Universitario Bariloche, Universidad Nacional del Comahue.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum, Part. 1: The Herbaria of the World. 8th edn. *Regnum Vegetabile* 120: 1–693.
- Jaczewski AA. 1927. Karmannyj opredelitel' gribov. Vyp. 2. Muchnisto-rosjannye griby. Leningrad.
- Mazzanti de Castañón MA, Cabrera de Alvarez MG. 1985. Estudio de oidios (formas sexuales y asexuales) registrados sobre cinco especies ornamentales en Corrientes, Argentina. *Trabajos y Comunicaciones del 2. Congreso Latinoamericano de Fitopatología*, Buenos Aires, 2–26 Noviembre: 73–90.
- Patil SD. 1962. The genus *Phyllactinia* Lév. in Maharashtra State. *Journal of the University of Poona, Science and Technology Section* 22: 119–125.
- Paul YS, Thakur VK. 2006. *Indian Erysiphaceae*. Scientific Publishers, Jodhpur.
- Pirozynski KA. 1965. *Ovulariopsis* state of *Pleochaeta*. *Mycologia* 57: 826–828.
- Shin HD, Lee HJ. 2002. Morphology of penicillate cells in the genus *Phyllactinia* and its taxonomic application. *Mycotaxon* 83: 301–325.
- Sydow H. 1935. Beschreibungen neuer südafrikanischer Pilze. VI. *Annales Mycologici* 33(3–4): 230–237.
- Takamatsu S, Inagaki M, Niinomi S, Khodaparast SA, Shin HD, Grigaliunaite B, Havrylenko M. 2008. Comprehensive molecular phylogenetic analysis and evolution of the genus *Phyllactinia* (*Ascomycota: Erysiphales*) and its allied genera. *Mycological Research* 112: 299–315.
- Tao JF, Qin JZ, Shen YZ. 1980. A new species of *Erysiphaceae*. *Acta Microbiologica Sinica* 20(2): 122–123.
- Xie DZ. 1992. A new species of *Phyllactinia* (*Erysiphaceae*). *Acta Mycologica Sinica* 11: 96–98.
- Yu YN, Lai YQ, Han SJ. 1979. Taxonomic studies on the genus *Phyllactinia* of China. III. *Phyllactinia* with long perithecial appendages. *Acta Microbiologica Sinica* 19(2): 131–145.

A survey of the corticioid fungi from the Biosphere Reserve of Las Batuecas-Sierra de Francia (Spain)

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Abstract — 140 species belonging to 55 genera of corticioid fungi are reported from the Biosphere Reserve of Las Batuecas-Sierra de Francia in central-western Spain. *Amyloathelia amylacea*, *Phlebia* cf. *lacteola*, *Sistotrema alboluteum*, *S. porulosum*, *S. subtrigonospermum*, and *Vuilleminia alni* are new records for the Iberian Peninsula. The presence of *Hjortstamia crassa* recently re-collected in Europe after one century is remarkable. A complete checklist of fungi, descriptions, and line drawings for the Iberian novelties are available on <http://www.mycotaxon.com/resources/weblist.html>.

Key words — *Aphyllophorales*, chorology, Mediterranean

Introduction

The Natural Park of “Las Batuecas-Sierra de Francia”, declared a Biosphere Reserve in 2006, is situated in the south of Salamanca province in the central-western part of the Iberian Peninsula (40°26'–40°35' N, 5°57'–6°15' W) and covers an area of 320 km². The reserve has a typically humid, Mediterranean climate and the main forest formations are: deciduous forests of *Quercus ilex* subsp. *ballota* (Desf.) Samp., *Q. suber* L., *Q. faginea* Lam., *Q. pyrenaica* Willd., *Q. robur* L., *Castanea sativa* Mill., *Arbutus unedo* L., and *Eucalyptus camaldulensis* Dehnh.; coniferous forests of *Pinus pinaster* Aiton, *P. sylvestris* L., and *Juniperus oxycedrus* L.; and riparian formations of *Alnus glutinosa* (L.) Gaertn., *Salix* spp. and *Populus* spp. Despite being declared a Biosphere Reserve (mainly based on the interesting Mediterranean vegetation, animal communities and socio-cultural patrimony) only a few fungal studies have been undertaken in the

area (Daniëls & Gorjón 2009, Gorjón & Bernicchia 2009, Gorjón et al. 2007). Present survey constitutes the first long-term, systematized study of corticioid species.

Materials and methods

During 2002–07 fungi were collected on different kinds of substrate in the area studied. Samples were examined following classical methods. Sections were mounted in KOH (5%), cotton blue and/or Melzer's reagent and studied using a Leica DMRD microscope; line drawings were made from images acquired with a Leica DC100 camera and Leica QWin image system. Specimens are kept in SALA, some duplicates also in HUBO and GU. Nomenclature mainly follows CBS (2009).

Results

In this survey 140 species belonging to 55 genera of corticioid wood-inhabiting fungi were identified. Species of *Hyphodontia*, *Tomentella*, *Botryobasidium*, *Phanerochaete*, and *Hyphoderma* were dominant. The annotated species checklist posted on the internet provides additional taxonomical, ecological and chorological comments for all species.

Amyloathelia amylacea (Bourdot & Galzin) Hjortstam & Ryvarden, *Phlebia* cf. *lacteola* (Bourdot) M.P. Christ., *Sistotrema alboluteum* (Bourdot & Galzin) Bondartsev & Singer, *S. porulosum* Hallenb., *S. subtrigonospermum* D.P. Rogers (see also Gorjón & Hallenberg 2008), and *Vuilleminia alni* Boidin et al. are new records for the Iberian Peninsula.

Rare or infrequent species in the Iberian Peninsula are *Aleurodiscus aurantius* (Pers.) J. Schröt., *Botryobasidium asperulum* (D.P. Rogers) Boidin, *Bulbillomyces farinosus* (Bres.) Jülich, *Ceraceomyces sulphurinus* (P. Karst.) J. Erikss. & Ryvarden, *Dacryobolus sudans* (Alb. & Schwein.) Fr., *Hjortstamia crassa* (Lév.) Boidin & Gilles, *Hyphodontia cineracea* (Bourdot & Galzin) J. Erikss. & Hjortstam, *H. rimosissima* (Peck) Gilb., *Phanerochaete avellanea* (Bres.) J. Erikss. & Hjortstam, *Phlebia ochraceofulva* (Bourdot & Galzin) Donk, *P. subochracea* (Alb. & Schwein.) J. Erikss. & Ryvarden, *Stereum illudens* Berk., *S. reflexulum* D.A. Reid, *Tomentella botryoides* (Schwein.) Bourdot & Galzin, *Tubulicrinis borealis* J. Erikss., and *Vuilleminia cystidiata* Parmasto.

Some species seem to have a mainly Mediterranean distribution, such as *Byssomerulius hirtellus* (Burt) Parmasto, *Peniophora meridionalis* Boidin, *Phanerochaete martelliana* (Bres.) J. Erikss. & Ryvarden, *Scytinostroma aluta* Lanq., and *Stereum reflexulum*. Substrates that are particularly species-rich are *Quercus pyrenaica* (54 species), *Pinus pinaster* (40), *Arbutus unedo* (37), *Pinus sylvestris* (34), and *Quercus ilex* (33).

Discussion

The Iberian Peninsula has been very well investigated, however six species are considered new records. *Amyloathelia amylacea* is a rare species in southern Europe but cosmopolitan and widely distributed in the northern hemisphere; in the studied area it is quite frequent on still-attached, dead branches of juniper. The specimen identified as *Phlebia* cf. *lacteola* belongs to us to the *Phlebia lilascens* (Bourd.) J. Erikss. & Hjortstam complex. *Phlebia lilascens* differs mainly by colour but the colour is often dependent on the kind of substrate it is growing on. Moreover, within *P. lilascens* there are cryptic species with a very big overlap in morphology. Because of its whitish fruitbody and different spore size we prefer to continue to keep this specimen as *Phlebia* cf. *lacteola*, and wait for further accumulation of specimens. *Vuilleminia alni* seems to be a species closely related or identical to *Vuilleminia comedens* (Nees) Maire. This species differs slightly from *V. comedens* in colour and spore size and cultural studies by Boidin et al. (1994) show incompatibility between *V. alni* and *V. comedens*, but initial molecular studies (Ghobad-Nejhad & Hallenberg, unpublished) do not provide clear evidence for keeping the two species separate.

Hjortstamia crassa was also recently collected in the north of the Iberian Peninsula by Salcedo & Olariaga (2008) and has now also been found in the studied area. It is a very interesting record because in Europe it was previously known from the only Polish collection (Bresadola 1903) and it has probably become extinct in this collecting site (Snowarski 2006).

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Literature cited

- Boidin J, Lanquetin P, Gilles G. 1994. Contribution à la connaissance du genre *Vuilleminia* (*Basidiomycotina*). Bull. Soc. Mycol. Fr. 110 (2): 91–107.
- Bresadola G. 1903. Fungi Polonici a el. Viro B. Eichler lecti. Ann. Mycol. 1(1–2): 65–131.
- CBS. 2009. *Aphylllophorales* database. www.cbs.knaw.nl/databases/index.htm.
- Daniëls PP, Gorjón SP. 2009. *Ramaria mediterranea* (*Gomphales*, *Basidiomycota*), segunda cita para la Península Ibérica. Bol. Soc. Micol. Madrid (in press)
- Gorjón SP, Bernicchia A. 2009. *Antrodia sandaliae* (*Polyporales*, *Basidiomycota*), an interesting polypore collected in the Iberian Peninsula. Cryptog. Mycol. 30(1): 53–56.

- Gorjón SP, García Jiménez P, Sánchez Sánchez J. 2007. Listado preliminar de *Ascomycota* presentes en el Parque Natural de “Las Batuecas Sierra de Francia” (Salamanca, España). *Stud. Bot.* 26: 125–129.
- Gorjón SP, Hallenberg N. 2008. New records of *Sistotrema* species (*Basidiomycota*) from the Iberian Peninsula. *Sydowia* 60(2): 205–212.
- Salcedo I, Olariaga I. 2008. *Phanerochaete crassa* (Lév.) Burds., nueva cita para la micoflora de la Península Ibérica. *Revista Catalana Micol.* 30: 93–99.
- Snowarski M. 2006. Mushrooms and fungi of Poland. Polish red list of macro fungi. <http://www.grzyby.pl/czerwona-lista-Aphyllphorales.htm>

***Umbilicaria isidiosa* (lichenized Ascomycota), a new species from Bolivia**

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Abstract — *Umbilicaria isidiosa*, a new species from Bolivia, is described. It is characterized by the ashy brown to mouse grey, pruinose, smooth to slightly scabrous upper surface of its thallus with numerous globular to richly branched isidia clustered at its margin, and a lower surface that is blackish and smooth to scabrous with sparse, blackish rhizines.

Key words — taxonomy, new records, South America

Introduction

The lichen genus *Umbilicaria* Hoffm. currently comprises more than 90 accepted species, which are widely distributed, especially in polar and mountainous regions. Although species are relatively well-known since the monographs by Frey (1933) and Llano (1950), some new species are still being discovered, such as *U. subcalvescens* Sipman from Colombia (Sipman & Topham 1992), *U. pseudocinerascens* J.C. Wei & Y.M. Jiang and *U. loboperipherica* J.C. Wei et al. from China (Wei & Jiang 1988, Wei et al. 1996), *U. kappenii* Sancho et al. from Antarctica (Sancho et al. 1998) and *U. murihikuana* D.J. Galloway & Sancho from New Zealand (Galloway & Sancho 2005).

The lichen biota of South America have more recently proved of special interest and extensive investigations have been conducted there (see Marcelli & Seaward 1998 for a summary); Feuerer et al. (1998), who cited only 210 known species in Bolivia, estimated there might be up to 2500 species in the country. During the last ten years, intensive fieldwork carried out in Latin America, including Bolivia, has resulted in many new species and records (e.g. Ferraro 2002, Feuerer & Sipman 2005, Galloway 2005, Flakus & Wilk 2006, Flakus et al. 2006, Flakus & Kukwa 2007, Flakus & Lücking 2008, Knudsen et al. 2008). As regards the family *Umbilicariaceae*, Hestmark (1997) started collecting data

in 1994 in anticipation of a contribution to the Flora Neotropica monographs (G. Hestmark, in litt.).

The lichenological investigations carried out in Bolivia in 2004 by Polish lichenologists resulted in the collection of some very interesting specimens of *Umbilicaria* (as many as 16 taxa, Krzewicka & Flakus, in press), including *U. isidiosa*, a new species described here.

Materials and methods

Lichen material from KRAM, LPB and M herbaria was examined using standard microscopic techniques. All measurements were made in 5% KOH solution. Thin layer chromatography (TLC) was performed in solvent A (Orange et al. 2001).

Taxonomic description

Umbilicaria isidiosa Krzewicka, sp. nov.

PLATE 1

MYCOBANK 513413

Thallus monophyllus, umbilicatus, orbiculatus vel irregularis, 1–4(–5) cm diametro, margine saepe incise-lobatus. Superficies superior laevis vel tenuiter scabrida, cinerea, pruinosa. Superficies inferior nigra vel fuliginosa, exasperata vel areolato-scabrida. Thalloconidia absens. Isidia obscura fusca, globosa vel ramosa, aggregata ad margine, 50 × 50–100 µm diam.

TYPE: BOLIVIA, DEPARTMENT SANTA CRUZ, Province of Manuel Maria Caballero, East Cordillera, NW of Comarapa city, Siberia village, 3480 m a.s.l., (64°45'14"W 17°49'38"S) on sandstone in open area, 15 December 2004, A. Flakus 5696 (KRAM-L 53288 – holotype; LPB, herb. Flakus – isotypes).

DESCRIPTION – Thallus foliose, umbilicate, thick, rigid, monophyllous, rarely polyphyllous, orbicular to irregular, 1–4(–5) cm in diam. Margin shallow incised, lacerate and undulate, covered by dark brown isidia. Upper surface dull, more or less uniformly coloured, ashy brown or mouse grey, pruinose, smooth to slightly scabrous, plane, without pustules. Lower surface minutely roughened to markedly areolate-scabrid, without trabecules, black, towards the margin paler, dark brown or medium brown. Rhizines very rare present, occasional, simple, cylindrical, dark brown to black, at or near margins. Umbilicus short, black, compact, asymmetric. Isidia clustered on upper surface at margin, rarely scattered through upper surface and on lower cortex of curled up lobes, glossy, dark brown to blackish, coralloid or densely branched, globular to cylindrical, 50 × 50–100 µm diam. Thalloconidia absent. Apothecia not observed.

Thallus up to 180–300 µm thick. Upper cortex two-layered: epinecral layer up to 20–25 µm thick, discontinuous, eroded and paraplectenchymatous layer, up to 30–40 µm thick, brown pigmented in upper part. Algal layer 30–40(–80) µm thick, more or less continuous, algal cells up to 8–10 × 8–10 µm in diam. not aggregated. Medulla prosoplectenchymatous, up to 80–110 µm thick, one

layered, composed of loosely interwoven, mainly horizontally oriented hyphae, with many intercellular air spaces, havaasii type (Valladares & Sancho 1995). Lower cortex up to 20–40(–60) μm thick, dark brown, paraplectenchymatous.

CHEMISTRY – gyrophoric acid detected by TLC.

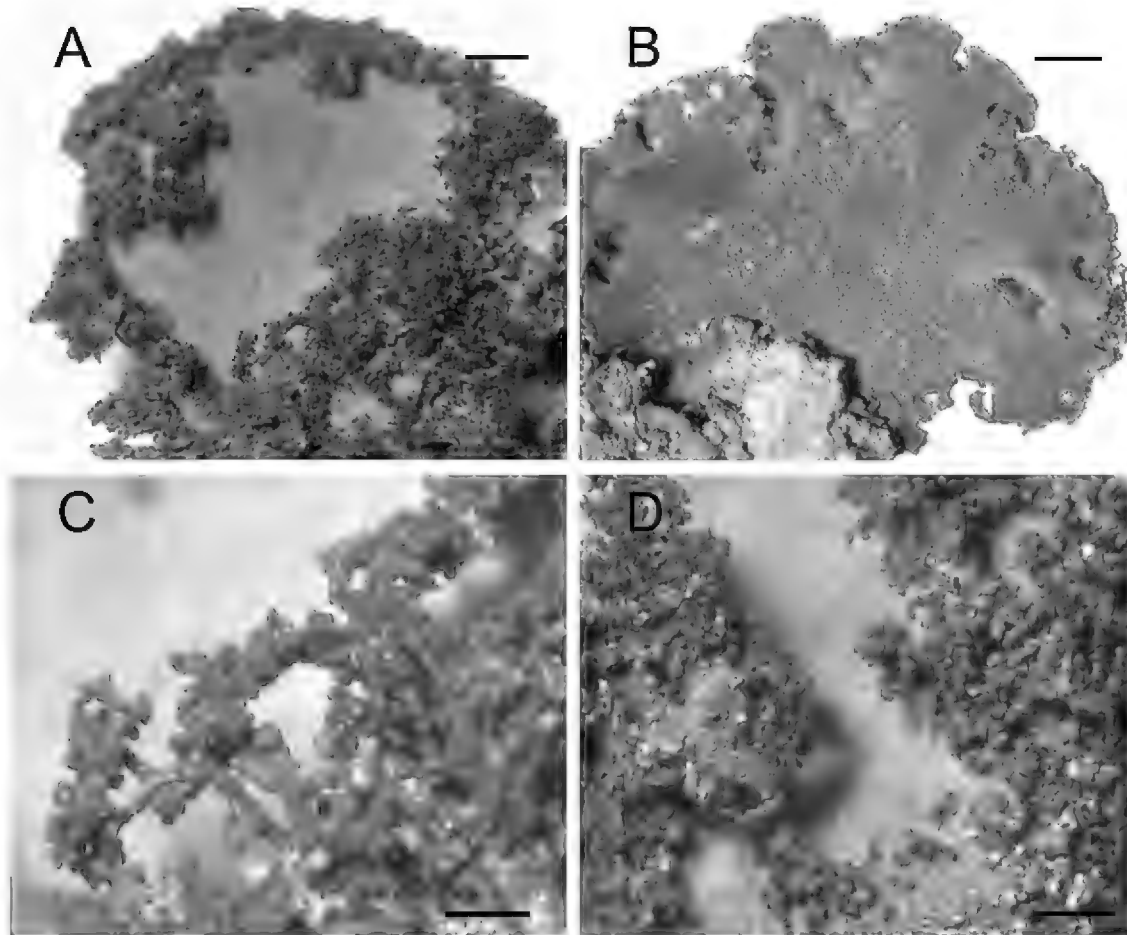


Plate 1. *Umbilicaria isidiosa* (holotype).

A – upper surface; B – lower surface; C – isidia at margin; D – isidia on upper surface.

Scale bar A–B = 1mm, C = 0.2 mm, D = 0.5 mm.

ECOLOGY AND DISTRIBUTION – *Umbilicaria isidiosa* occurs on siliceous sandstones in exposed, sunny, windy, and humid places; the humidity results from periodic fogs. It grows on large blocks of rock up to 1 m in height scattered over an agriculture area at the fringes of the Yungas cloud forest. It is accompanied by *Aspicilia*, *Caloplaca*, *Rhizocarpon* and *Usnea* spp. Other *Umbilicaria* species were not observed in the area investigated. This new species is known only from the type locality in the Bolivian Andes on the East Cordillera, on the slope of hill above Siberia village at 3480 m a.s.l., where it appears to be quite abundant.

ADDITIONAL SPECIMEN EXAMINED – BOLIVIA, DEPARTMENT SANTA CRUZ, Province of Manuel Maria Caballero, East Cordillera, NW of Comarapa city, on hill above Siberia village, 3480 m a.s.l., (64°45'14"W 17°49'38"S) on sandstone, in open, sunny area, 15 December 2004, K. Wilk 3098b (KRAM-L 53289).

COMMENTS – Vegetative propagules are excellent diagnostic characters for several species, e.g. soredia for *U. kappenii* and *U. soralifera* (Frey) Krog & Swinscow, parasoredia for *U. grisea* Hoffm. and *U. hirsuta* (Westr.) Hoffm., schizidia for *U. freyi* Codogno et al. and *U. leprosa* (Zahlbr.) Frey, and squamose lobules for *U. loboperipherica* and *U. thamnones* Hue (Frey 1949, Codogno et al. 1989, Wei et al. 1996, Sancho et al. 1998). The only *Umbilicaria* species producing true isidia is *U. deusta* (L.) Baumg., which is easily distinguished from *U. isidiosa* by its very thin and fragile thallus with a medium to dark brown, smooth to slightly wrinkled upper surface and pale to dark brown (rarely black) pitted lower surface without rhizines (Krzewicka 2004). Moreover, in *U. deusta* the isidia are concolorous with the upper cortex, i.e. brown to dark brown, minute, granular, occurring mainly along cracks and abrasions through the upper surface, whereas in *U. isidiosa* the isidia are distinctly darker than the upper cortex, dark brown to blackish, coralloid, densely branched, globular to cylindrical, clustered on upper surface at margin, rarely scattered throughout the upper surface. The isidia of *U. isidiosa* also occur on the lower cortex of the curled up lobes, which has never been observed in the case of *U. deusta*.

Furthermore, the species appear to differ in their world distribution. *Umbilicaria deusta* is a circumboreal-montane species occurring mainly in the Northern Hemisphere where it is one of the most frequent species of this genus (Llano 1950). Recently, it has been also reported from South America (Hestmark 2004) and from New Zealand (Galloway & Ledingham 2006). However, *U. isidiosa* is currently known from only a small area in the Bolivian Andes.

Owing to the marginal dark brown, multi-divided isidia (PLATE 1), giving a ciliate appearance to the thallus, *U. isidiosa* could be confused with *U. dendrophora* (Poelt) Hestmark, a taxon occurring in South America (Hestmark 1997) or *U. umbilicarioides* (Stein) Krog & Swinscow, a taxon widespread in Antarctic region (Øvstedal & Lewis Smith 2001, Krzewicka & Smykla 2004) which create rhizines bearing multi-cellular thalloconidia at their thallial margins (Krog & Swinscow 1986, Hestmark 1990, 1993). By careful study, one can easily recognize these taxa by their asexual propagules. *Umbilicaria umbilicarioides* and *U. dendrophora* are distinguished from the new species by the presence of multi-cellular thalloconidia on rhizines, whereas *U. isidiosa* lacks thalloconidia but produces isidia. An additional distinguishing character is the abundance of richly branched rhizines in the case of *U. umbilicarioides* and *U. dendrophora*, but these are sparse and simple in *U. isidiosa*.

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Literature cited

- Codogno M, Poelt J, Puntillo D. 1989. *Umbilicaria freyi* spec. nov. und der Formenkreis von *Umbilicaria hirsuta* in Europa (Lichenes, *Umbilicariaceae*). *Plant Systematics and Evolution* 165: 55-69.
- Ferraro LI. 2002. Contribution to the knowledge of foliicolous lichens of Bolivia. *Mitteilungen aus dem Institut für allgemeine Botanik in Hamburg* 30-32: 47-48.
- Feuerer T, Sipman HJM. 2005. Additions to the lichenized and lichenicolous fungi of Bolivia. *Herzogia* 18: 139-144.
- Feuerer T, Ahti T, Vitikainen O. 1998. Lichenological investigations in Bolivia. 71-86, in MP Marcelli, MRD Seaward (eds.), *Lichenology in Latin America: history, current knowledge and applications*. São Paulo, CETESB.
- Flakus A, Kukwa M. 2007. New species and records of *Lepraria* (*Stereocaulaceae*, lichenized *Ascomycota*) from South America. *Lichenologist* 39: 463-474.
- Flakus A, Kukwa M, Czarnota P. 2006. Some interesting records of lichenized and lichenicolous *Ascomycota* from South America. *Polish Botanical Journal* 51: 209-215.
- Flakus A, Lücking R. 2008. New species and additional records of foliicolous lichenized fungi from Bolivia. *Lichenologist* 40: 423-436.
- Flakus A, Wilk K. 2006. Contribution to the knowledge of the lichen biota of Bolivia. *Journal of the Hattori Botanical Laboratory* 99: 307-318.
- Frey E. 1933. *Cladoniaceae, Umbilicariaceae*. In: Rabenhorst's Kryptogamen-Flora von Deutschland, Österreich und der Schweiz. 4: 203-411. Leipzig, Akademische Verlagsgesellschaft M.B.H.
- Frey E. 1949. Neue Beiträge zu einer Monographie des Genus *Umbilicaria* Hoffm. Bericht der Schweizerischen Botanischen Gesellschaft. *Bulletin de la Société Botanique Suisse* 59: 427-470.
- Galloway DJ. 2005. *Placopsis fusciculoides* (*Ascomycota: Agyriaceae*), a new lichen from Aotearoa New Zealand, British Columbia, and Bolivia. *Australasian Lichenology* 57: 16-19.
- Galloway DJ, Sancho LG. 2005. *Umbilicaria murihikuana* and *U. robusta* (*Umbilicariaceae: Ascomycota*), two new taxa from Aotearoa New Zealand. *Australasian Lichenology* 56: 16-19.
- Galloway DJ, Ledingham J. 2006. Additional lichen records from New Zealand 43. *Umbilicaria deusta* (L.) Baumg. *Australasian Lichenology* 58: 14-16.
- Hestmark G. 1990. Thalloconidia in the genus *Umbilicaria*. *Nordic Journal of Botany* 9: 547-574.
- Hestmark G. 1993. *Umbilicaria dendrophora*. *Mycotaxon* 46: 211-215.
- Hestmark G. 1997. Species diversity and reproductive strategies in the family *Umbilicariaceae* on high equatorial mountains – with remarks on global patterns. *Bibliotheca Lichenologica* 68: 195-202.
- Hestmark G. 2004. *Umbilicaria*. 548-556, in TH Nash III, BD Ryan, P Diederich, C Gries, F Bungartz (eds.), *Lichen Flora of the Greater Sonoran Desert Region. II*. Tempe, Arizona, Lichens Unlimited, Arizona State University.
- Knudsen K, Elix JA, Reeb V. 2008. A preliminary study of the genera *Acarospora* and *Pleopsidium* in South America. *Opuscula Philolochenum* 5: 1-22.

- Krog H, Swinscow TDV. 1986. The lichen genera *Lasallia* and *Umbilicaria* in East Africa. *Nordic Journal of Botany* 6: 75-85.
- Krzewicka B. 2004. The lichen genera *Lasallia* and *Umbilicaria* in the Polish Tatra Mts. *Polish Botanical Studies* 17: 1-88.
- Krzewicka B, Smykla J. 2004. The lichen genus *Umbilicaria* from the neighbourhood of Admiralty Bay (King George Island, maritime Antarctic), with a proposed new key to all Antarctic taxa. *Polar Biology* 28: 15-25.
- Llano GA. 1950. A Monograph of the Lichen Family *Umbilicariaceae* in the Western Hemisphere. Washington, D.C., Office of Naval Research.
- Marcelli MP, Seaward MRD (eds.). 1998. Lichenology in Latin America: history, current knowledge and applications. São Paulo, CETESB.
- Orange A, James PW, White FJ. 2001. Microchemical methods for the identification of lichens. London, British Lichen Society.
- Øvstedal DO, Lewis Smith RI. 2001. Lichens of Antarctica and South Georgia. A Guide to their Identification and Ecology. Cambridge, Cambridge University Press.
- Sancho LG, Schroeter B, Valladares F. 1998. *Umbilicaria kappenii* (*Umbilicariaceae*) a new lichen species from Antarctica with multiple mechanisms for the simultaneous dispersal of both symbionts. *Nova Hedwigia* 67: 279-288.
- Sipman HJM, Topham P. 1992. The genus *Umbilicaria* (lichenized ascomycetes) in Colombia. *Nova Hedwigia* 54: 63-75.
- Valladares F, Sancho LG. 1995. Medullary structure of *Umbilicariaceae*. *Lichenologist* 27: 189-199.
- Wei J, Jiang, Y. 1988. A conspectus of the lichenized *Ascomycetes*. *Umbilicariaceae* in China. *Mycosystema* 1: 73-106.
- Wei J, Jiang Y, Guo S. 1996. A new species of *Umbilicaria*. *Mycosystema* 8-9: 65-70.

Notes on the lichen genus *Bacidia* s.l. (lichenized *Ascomycota*) in the Cape Verde Islands and new lichen records for the archipelago

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Abstract — Five species belonging in *Bacidia* s. l. are newly reported from Cape Verde Islands and discussed. Four species belong to *Bacidia*: *B. atlantica*, *B. polychroa*, *B. subincompta*, and *B. trichosperma*; and one species to *Bacidina*: *B. pallidocarnea*. Four other species are also newly reported: *Buellia dispersa*, *Cresponea flava*, *Fellhaneropsis vezdae*, and *Toninia submexicana*. The new combination *Bactrospora thyrsoidea* is proposed for *Bacidia thyrsoidea*.

Key words — Atlantic islands, biogeography, Macaronesia, new records, taxonomy

Introduction

Mies (1993) published a critical compilation of species belonging to *Bacidia* De Not., considered in a wide sense, found in the Cape Verde Islands. In his checklist, Mies cited five species without further comment, reporting three species (*Bacidia effusa*, *Bacidia* sp. A, and *Bacidia* sp. B) from just one island, *B. laurocerasi* from two islands, and *B. thyrsoidea* from five islands.

The aim of our current paper is to revisit *Bacidia* s. l. in the Cape Verde archipelago in greater depth and to compare the distribution of the treated species in the Macaronesian archipelagos.

Material and methods

The Cape Verde Islands are situated in the Atlantic Ocean located near the west coast of Africa between 14°48' and 17°12' N, and 25°42' to 22°41' W.

This study is based on specimens identified as *Bacidia* collected on Cape Verdean islands and borrowed from the herbaria BM and M, as well as on samples collected by P. & B. v. d. B. in July 2006, from Santo Antão, São Tiago and São Vicente of the archipelago. These have been examined by stereomicroscope and light microscope using the standard techniques.

Results

The study of the available collections has shown that five species belonging in *Bacidia* s.l. occur in the Cape Verde Archipelago. One species, *Bacidia thyrsodes*, is excluded from *Bacidia* and a new combination is made. In addition, four species misidentified as *Bacidia* are reported as new for the lichen flora of Cape Verde.

Bacidia atlantica (Müll. Arg.) Zahlbr.

Thallus grey green, granular to areolate, areoles sometimes resembling squamulose when margins rise; surface disaggregating into goniocysts 30–60 µm wide; upper cortex prosoplectenchymatous. Algae chlorococcoid, 5–8 µm diam. Apothecia orange to reddish, 0.35–0.65 mm wide; with a well developed proper margin, paler than the disc; disc flat, finally slightly swollen, with a darker rim. Exciple colourless, prosoplectenchymatous, made of branched and anastomosed hyphae with cell lumina of $12 \times 2\text{--}3.5$ µm. Hypothecium prosoplectenchymatous, yellowish, reacting K⁺ intensifying, rubella-orange pigment present. Hymenium colourless, 60–70 µm thick; upper hymenium not differentiated, sometimes small crystals present that solve in KOH. Paraphyses not or slightly agglutinated, not anastomosed, apices not swollen, 1.5 µm thick. Asci clavate, 8-spored, 40–60 × 7–10 µm, *Bacidia*-type. Ascospores colourless, long bacilliform, not or slightly tapering to one end, (20–)22–39 × 2–3(–3.5) µm, with 3–5 septa. Pycnidia not seen.

Because of the thallus morphology, *B. atlantica* resembles the pantropical *B. medialis* (Tuck.) B. de Lesd. However, the rim of the exciple is pigmented pale orange-brown and ascospores are shorter and narrower in the latter.

This taxon was previously known only from Ascension Island, from where it was described. This is the first report of this species for the Cape Verde archipelago. Its current range suggests a tropical Middle Atlantic distribution, although it could have been overlooked elsewhere.

SPECIMENS EXAMINED - SANTO ANTÃO: SW OF VILA DAS POMBAS, Figueiral de Paúl, SW part of the valley, Chã de Padre, small coffee plantation, scattered mixed trees, acidic outcrops, 25° 03.0' W, 17° 07.0' N, 195 m, on *Coffea*, 21.VII.2006. P. & B. v. d. Boom 36857 (hb. v. d. Boom). SÃO TIAGO: W OF SÃO DOMINGOS, WNW of Rui Vaz, along path to "Monte Tchopa", E of telecommunication station, hilly area with mixed trees, 1035 m, on *Mangifera*, 8.VII.2006, P. & B. v. d. Boom 36424 (hb. v. d. Boom); *ibid.* on *Hibiscus*, P. & B. v. d. Boom 36418 (hb. v. d. Boom).

***Bacidia polychroa* (Th. Fr.) Korb.**

Most of the specimens identified as *B. polychroa* have been previously identified under *B. effusa* (Sm.) Trev., a synonym for *Bacidina assulata* (Korb.) S. Ekman, and *Bacidia laurocerasi* (Delise ex Duby) Zahlbr. *Bacidia polychroa* differs from *Bacidina assulata* in the size of ascospores, which are $(30-40-60(-75) \times (2-2.5-4 \mu\text{m})$ in the former, and $(28-32-49(-54) \times 1-2 \mu\text{m})$ in the latter; the structure of the exciple, prosoplectenchymatous and paraplectenchymatous respectively; and asci. The differences between *B. polychroa* and *B. laurocerasi* are based on the non-soluble pigments and the size of ascospores. The former has a red pigment (polychroa-red according to Meyer & Printzen, 2000) in the exciple, hypothecium, and subhymenium, which reacts K⁺ purplish. This pigment is also present, mixed with a low concentration of bagliettoana-green pigment, in the epihymenium. *Bacidia laurocerasi* lacks the polychroa-red pigment in exciple, hypothecium, and subhymenium. However, a certain amount of rubella-orange pigment is found, which reacts K⁺ intensifying the yellow or orange colour. In the epihymenium, the pigment is a mixture of laurocerasi-brown and bagliettoana-green. Ascospores of *B. polychroa* are slightly shorter and wider than those of *B. laurocerasi*, although this is not the best character by which to distinguish these taxa.

Bacidia polychroa has a boreal to temperate distribution, mainly in areas with humid climate. This species has not been recorded from the Macaronesia, but a careful study of samples determined as *B. laurocerasi* would result in misidentifications of *B. polychroa*, basically because some authors have included the concept of the latter into *B. laurocerasi*.

SPECIMENS EXAMINED - SANTO ANTÃO: S OF RIBEIRA GRANDE, Corda, centre of village, outcrops and roadside trees along main road, 1060 m, on *Pinus*, 17.VII.2006, P. & B. v. d. Boom 36660 (hb. v. d. Boom); *ibid.*, on *Acacia* sp., P. & B. v. d. Boom 36701 (hb. v. d. Boom). SÃO NICOLAU: MT. GORDO, NW-Hang, an Säumen von *Euphorbia tuckeyana*, 24°21' W, 16°38' N, 940 m, Expos. NW, 29.IX.1988, B. Mies 960i (M-0142068). SÃO TIAGO: W OF SÃO DOMINGOS, Rui Vaz, centre of village, mixed trees and outcrops along small road, 825 m, on *Casuarina*, 07.VII.2006, P. & B. v. d. Boom 36336 (hb. v. d. Boom); *ibid.*, on unidentified roadside tree, P. & B. v. d. Boom 36349 (hb. v. d. Boom). W OF SÃO DOMINGOS, WNW of Rui Vaz, along path to "Monte Tchopa", E of telecommunication station, hilly area with mixed trees, 1035 m, on Mimosaceae, 8.VII.2006, P. & B. v. d. Boom 36440 (hb. v. d. Boom); *ibid.* on shrub, P. & B. v. d. Boom 36445 (hb. v. d. Boom); *ibid.* on unidentified big tree, P. & B. v. d. Boom 36448 (hb. v. d. Boom). W OF SÃO DOMINGOS, N of Rui Vaz, along village, on rocky mountain, with some shrubs, 855 m, on shrub, 9.VII.2006, P. & B. v. d. Boom 36463, 36498, 36504 (hb. v. d. Boom). MONTE VERDE, just below top of the mountain, NW slope with acidic outcrops, shrubs and ±scattered small trees, 700 m, on shrub, 15.VII.2006, P. & B. v. d. Boom 36616 (hb. v. d. Boom); *ibid.* on rotting trunk of *Agave*, P. & B. v. d. Boom 36606 (hb. v. d. Boom). SÃO JORGE DAS ORGÃOS, am Staum von *Ceratonia siliqua*, 630 m, Expos. NE, 16.IX.1988, B. Mies 840n (M-0142052, 0142053).

Bacidia subincompta (Nyl.) Arnold

Features of the examined samples, such as the presence of bagliettoana-green pigment in the outer part of the exciple and upper hymenium, and reddish brown hypothecium, agree with *Bacidia subincompta*. However, the ascospores are slightly longer than European material; they measure 32–45 µm for 20–36 (–40) µm in European samples (Purvis et al. 1992, Llop 2007). The number of septa is also higher, 7 to 11 in the Cape Verdean samples for 5 to 7 in the European collections.

This species has a boreal to temperate distribution, and is known from Madeira (Hafellner 1995) and Canary Islands (van den Boom & Etayo 2006).

SPECIMENS EXAMINED - SANTO ANTÃO: S OF RIBEIRA GRANDE, SE of Corda, N of trail 203, from Chã de Mato to Losnã, small (secondary) trail to Fajã de Baixo, outcrops, boulders and walls along trail, 25° 04.5' W, 17° 08.1' N, 975 m, on *Eucalyptus*, 18.VII.2006, P. & B. v. d. Boom 36774 (hb. v. d. Boom); ibid., Corda, centre of village, outcrops and roadside trees along main road, 25° 05.3' W, 17° 07.9' N, 1060 m, on *Acacia*, 18.VII.2006, P. & B. v. d. Boom 36941 (hb. v. d. Boom).

Bacidia trichosperma (Müll. Arg.) Zahlbr.

Thallus pale greyish to green, granulose; granules up to 50 µm wide; hypothallus byssoid. Apothecia flesh to yellowish cream, 0.25–0.50 mm diam.; proper margin slightly thick, disc flat to rather swollen. Exciple colourless to pale yellowish at the basis, prosoplectenchymatous, made of branched and anastomosed hyphae with cell lumina of 5–10 × 2–3 µm; margin with a byssoid aspect. Hypothecium prosoplectenchymatous, colourless to pale yellowish, rubella-orange pigment present. Hymenium colourless, 40–45 µm thick; upper hymenium not differentiated. Paraphyses not to slightly agglutinate, not branched, not anastomosed; apical cells not swollen, 1–1.5 µm thick. Asci clavate, 8-spored, 30–35 × 7 µm, *Bacidia*-type. Ascospores colourless, acicular, 20–27 × 1–2 µm, 3–5 septa. Pycnidia not seen.

The features of our sample do not fit any hitherto known European or North American species (Ekman 1996, Llop 2007). Its characteristics appear closest to *B. trichosperma*, as compared to the available information by Dodge (1953). Some characters of thallus and apothecia resemble those of *Bapalmuia* Sérus., although the ascus structure and ascospores are completely different.

This African species is known elsewhere only from the Usambara Mountains (Tanzania) in the west regions of the African continent (Dodge 1953).

SPECIMENS EXAMINED - SÃO TIAGO: W of São Domingos, Rui Vaz, centre of village, mixed trees and outcrops along small road, 23° 36.0' W, 15° 02.1' N, 825 m, on *Eucalyptus*, 07.VII.2006, P. & B. v. d. Boom 36451 (hb. v. d. Boom).

***Bacidina pallidocarnea* (Nyl.) Vězda**

This taxon is pantropical and foliicolous, but can also be found in subtropical and even wet-temperate areas (Lücking 2008). It has been found on the remains of *Agave* leaves in Cape Verde, which are ecologically similar to twigs.

SPECIMENS EXAMINED - **SÃO VICENTE:** MONTE VERDE, just below top of the mountain, NW slope with acidic outcrops, shrubs and ±scattered small trees, 24° 56.0'W, 16° 52.2' N, 700 m, on rotting leaf of *Agave*, 15.VII.2006, P. & B. v. d. Boom 36600 (hb. v. d. Boom).

The next five species were misidentified as *Bacidia* but a careful examination has shown that the specimens represent very different genera from *Bacidia* s. l. In addition, most of them are new for the lichen flora of the Cape Verde Islands. We first propose a new combination for *Bacidia thyrsodes*:

***Bactrospora thyrsodes* (Stirt.) Llop & van den Boom comb. nov.**

MYCOBANK 513119

= *Lecidea thyrsodes* Stirt., J. Linn. Soc. London, Bot. 14: 368, 1874;

Bacidia thyrsodes (Stirt.) Zahlbr., Cat. Lich. Univ. 4: 245, 1926.

TYPE: CAPE VERDE. SANT VINCENT. 1987 (HOLOTYPE-BM !)

= *Lecidea heterobola* Cromb., J. Linn. Soc. London, Bot. 16: 214, 1877

= *Bactrospora carneopallida* Egea & Torrente, Lichenologist 25: 226, 1993.

TYPE: SPAIN. ISLAS CANARIAS: Lanzarote, MIRADOR DEL RIO, c. 400 m, rocas volcánicas, 13 January 1990, J. M. Egea (HOLOTYPE-MUB, ISOTYPE-GZU)

Some samples identified as *Bacidia thyrsodes* or *Bacidia* cf. from B. Mies' collection in M appear to be conspecific with *Bactrospora carneopallida*. The study of the type material of *Bacidia thyrsodes* showed that the specimen was also conspecific with *Bactrospora carneopallida*. Because the epithet *thyrsodes* has priority over *carneopallida*, we propose the new combination *Bactrospora thyrsodes* as the correct name for the taxon (McNeill et al. 2006: Art. 11.4).

This species was previously cited from Cape Verde by Egea & Torrente (1993b) as *Bactrospora carneopallida*. Its distribution ranges from Macaronesia to the European Atlantic coast (Paz-Bermúdez & López de Silanes 1998).

SPECIMENS EXAMINED - **SAL:** ALGUDEIRO, N Santa Maria, an Basaltblöcken, Substrat: Fels, Basalt, 22°56' W, 16°37' N, 10 m, Expos. N, 17.X.1988, B. Mies 1040b, 1040c, 1040d1 (M-0142072, 0142080, 0142076). **SANTO ANTÃO:** FONTAINHAS, N-Küste, an Basalt, Substrat: Fels, Basalt, 25°06' W, 17°12' N, 260 m, Expos. N, 21.X.1988, B. Mies 1191n (M-0142070). Ibid., S side above village, N exposed slope with acidic outcrops along trail, 25°06' W, 17°11' N, 245 m, 20.VII.2006, P. & B. van den Boom 36811 (hb. v.d. Boom). **SÃO VICENTE:** NW-HANG DES MT. VERDE, Punta Antonio Gomes, an Tuffblöcken, 50 m, 11.IX.1986, B. Mies 14d2 (M-0142069).

Buellia dispersa A. Massal.

This taxon has a disjunct distribution; it is known from the Mediterranean area and drier inner alpine valleys (Scheidegger 1993), Canary Islands (Hafellner 1995), and southwest North America (Bungartz et al. 2002).

SPECIMENS EXAMINED - **SAL:** MT. GRANDE, S unterhalb der Spitze, an Tuffit, Substrat: Fels, 22°54' W, 16°49' N, 370 m, Expos. E, 08.XI.1988, B. Mies 1059d (M-0142074, 0142079); *ibid.*, NE-Hang, an Tuffit, Substrat: Fels, Tuffit, 22°54' W, 16°49' N, 350 m, Expos. NE, 08.X.1988, B. Mies 1063g1 (M-0142078).

Cresponea flava (Vain.) Egea & Torrente

The examined specimens were misidentified as *Bacidia thyrsodes*, but the type collection of the latter proves to belong to the related genus *Bactrospora* A. Massal. (see above). *Cresponea* differs from *Bactrospora* in having conglutinated and frequently anastomosed paraphysoids (Grube 1998). *Cresponea flava* has a disjunct distribution in the Tropics, being known from southeast Asia, South America, and both African coasts (Egea & Torrente 1993a).

SPECIMENS EXAMINED - **BRAVA:** VINAGRE, Bewässerungsgebiet der W-Küste, Strassenbäume und Totholz, Substrat: Baum, 24°41' W, 14°52' N, 100 m, Expos. E, 10.XI.1988, A. Kalnins 1274c (M-0142077). **SÃO NICOLAU:** NW des Mt. Bissau, Ribeira zum Rib. Madeira Vermelha, an Basalt des Flussbettrands, Substrat: Fels, Basalt, 24°15' W, 16°37' N, 120 m, Expos. N, 11.XI.1988, B. Mies 1077d1 (M-0140271).

Fellhaneropsis vezdae (Coppins & P. James) Sérus. & Coppins

This is the first report of this taxon from the Cape Verde archipelago. Foliicolous and corticolous collections were previously reported from Madeira (Sérusiaux 1996) and Topham & Walker (1982) found it on bark in the Canary Islands.

SPECIMENS EXAMINED - **SÃO VICENTE:** MONTE VERDE, just below the top of the mountain, NW slope with acidic outcrops, shrubs and ±scattered small trees, 24° 56.0' W, 16° 52.2' N, 700 m, on *Casuarina*, 15.II.2006, P. & B. v. d. Boom 36598 (hb. v. d. Boom).

Toninia submexicana B. de Lesd.

This taxon was hitherto known only from North and South America (Timdal 1992). It differs from all previously reported species of *Toninia* in Cape Verde by its grey epithecium reacting K + violet and ascospore morphology.

SPECIMENS EXAMINED - **FOGO:** CHA DAS CALDEIRAS, N-Hang des Pico Novo, an Phonolith und über Feinerde, Substrat: Felse, Phonolith, Erde, 24°21' W, 14°57' N, 2675 m, Expos. N, 02.XI.1988, B. Mies 1241f1 (M-0142073).

Key to the species of *Bacidia* s. l. and allied species from Cape Verde

- 1a. Exciple carbonaceous, asci *Arthonia*-type2
- 1b. Exciple not carbonaceous, asci of different type3
- 2a. Paraphysoids branched, ascospores (30–)35–60(–65) × 3–4(–4.5) µm,
3–9 septate *Bactrospora thyrsodes*
- 2b. Paraphysoids not branched, sometimes anastomosed, ascospores
15–22(–24) × (4–)4.5–5.5 µm, 3(–5) septate *Cresponea flava*
- 3a. Ascus *Byssoloma*-type, paraphyses branched and anastomosed,
exciple red brown *Fellhaneropsis vezdae*
- 3b. Ascus type different, paraphyses not branched and anastomosed.....4
- 4a. Ascus *Lecanora*-type, exciple paraplectenchymatous, paraphyses with
a swollen apical cell, 4–5 µm thick *Bacidina pallidocarnea*
- 4b. Ascus *Bacidia*-type, exciple prosoplectenchymatous, paraphyses without
a swollen apical cell. 5
- 5a. Margin of exciple and upper hymenium olivaceous to blackish green,
K+ green and N+ violet *Bacidia subincompta*
- 5b. Margin of exciple and upper hymenium not green6
- 6a. Exciple and hypothecium reddish purple, K+ purple, ascospores
(30–)40–60(–75) × (2–)2.5–4 µm, (5–)7–15 septate *Bacidia polychroa*
- 6b. Exciple and hypothecium colourless to yellowish, ascospores smaller7
- 7a. Ascospores (20–)22–39 × 2–3(–3.5) µm, 3–7 septate, apothecia
orange to reddish, disc with a darker rim *Bacidia atlantica*
- 7b. Ascospores 20–27 × 1–2 µm, 3–5 septate, apothecia
fleshy to yellow cream, evenly pigmented *Bacidia trichosperma*

Discussion

The genera *Bacidia* and *Bacidina* are represented by five species, all new for the lichen flora of Cape Verde. The number of species representing *Bacidia* s. l. varies considerably across the Macaronesian archipelagos: Canary Islands 16 species, Madeira 10 species and Azores 5 species (Hafellner 1995, 1999, 2002, 2005; van den Boom & Etayo 2006, Llop et al. 2007). Although Cape Verde is sometimes not included in Macaronesia (Vanderpoorten et al. 2007), despite the distance between the archipelagos, the number from Cape Verde is similar to Azores, but the composition of species is completely different, even though there are few coincidences with the other islands (Canary Islands and Madeira).

Biogeographically, the species of *Bacidia* s. l. show three distributional patterns. A Macaronesian-Mediterranean distribution is shown by *Bacidia polychroa*, *B. subincompta*, *Bacidina pallidocarnea*, and *Fellhaneropsis vezdae*. These species grow on the Mediterranean pluviseasonal oceanic bioclimate belt.

This belt is occupied by laurisilva or bush communities that replace the forest after alteration (Duarte et al. 2005). *Bacidia atlantica* represents a Mid-Atlantic endemism (Mies & Lösch 1995), as it occurs only in Ascension Island and Cape Verde. The third pattern (as shown by *Bacidia trichosperma*) corresponds to a tropical distribution, basically including mainland Africa. Other species from the archipelago with a similar distribution include *Heterodermia isidiophora* (Nyl.) D.D. Awasthi (Mies & Lösch 1995). Vanderpoorten et al. (2007) also suggests an affinity of the Cape Verde cryptogamous flora with that of continental Africa.

Those aforementioned species not belonging to *Bacidia* s. l. show a different distribution pattern, except for *Toninia submexicana*. They are growing on the Mediterranean xeric or desert belt, showing a tropical to subtropical arid distribution. In addition, these species are saxicolous. This pattern occurs equally among bryophytes from the driest Macaronesian islands (González-Mancebo et al. 2008). *Toninia submexicana* has a disjunct distribution, as it was known from North and South America (Timdal 1992). This species grows above the Mediterranean pluviseasonal oceanic belt, which has a drier climate.

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Literature cited

- Bungartz F, Scheidegger C, Nash III TH. 2002. *Buellia dispersa* A. Massal., a variable lichen species from semi-arid to arid environments of North America and Europe. *Bibliotheca Lichenologica* 82: 19–35.
- Dodge CW. 1953. Some lichens from tropical Africa. *Annals of the Missouri Botanical Garden* 40: 271–401.
- Duarte MC, Rego F, Moreira I. 2005. Distribution patterns of plant communities on Santiago Island, Cape Verde. *Journal of Vegetation Science* 16: 283–292.
- Egea JM, Torrente P. 1993a. *Cresponea* a new genus of lichenized fungi in the order Arthoniales (Ascomycota). *Mycotaxon* 48: 301–331.
- Egea JM, Torrente P. 1993b. The lichen genus *Bactrospora*. *Lichenologist* 25: 211–255.
- Ekman S. 1996. The corticolous and lignicolous species of *Bacidia* and *Bacidina* in North America. *Opera Botanica* 127: 1–148.
- González-Mancebo J, Romaguera F, Ros RM, Patiño J, Werner O. 2008. Bryophyte flora of the Canary Islands: an updated compilation of the species list with an analysis of distribution patterns in context of the Macaronesian Region. *Cryptogamie Bryologie* 29: 315–357.
- Grube M. 1998. Classification and phylogeny in the *Arthoniales* (lichenized *Ascomycetes*). *Bryologist* 101: 377–391.

- Hafellner J. 1995. A new checklist of lichens and lichenicolous fungi of insular Laurimacaronesia including a lichenological bibliography for the area. *Fritschiana* 5: 1–132.
- Hafellner J. 1999. Additions and corrections to the checklist and bibliography of lichens and lichenicolous fungi of insular Laurimacaronesia. I. *Fritschiana* 17: 1–26.
- Hafellner J. 2002. Additions and corrections to the checklist and bibliography of lichens and lichenicolous fungi of insular Laurimacaronesia. II. *Fritschiana* 36: 1–10.
- Hafellner J. 2005. Additions and corrections to the checklist and bibliography of lichens and lichenicolous fungi of insular Laurimacaronesia. III. *Fritschiana* 50: 1–13.
- Llop E. 2007. Flora Liqueológica Ibérica. III. Lecanorales. Bacidiaceae I. Barcelona, SEL.
- Llop E, Ekman S, Hladun NL. 2007. *Bacidia thyrronica* (Ramalinaceae, lichenized Ascomycota), a new species from the Mediterranean region, and a comparison of European members of the *Bacidia rubella* group. *Nova Hedwigia* 85: 445–455.
- Lücking R. 2008. Foliicolous lichenized fungi. *Flora Neotropica Monograph* 103: 1–867.
- McNeill J, Barrie FF, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema J, Turland NJ. 2006. International Code of Botanical Nomenclature (Vienna Code). Adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. *Regnum Vegetabile* 146. 568 p.
- Meyer B, Printzen C. 2000. Proposal for a standardized nomenclature and characterization of insoluble lichen pigments. *Lichenologist* 32: 571–583.
- Mies BA. 1993. Critical checklist of lichens and allied fungi of the Cape Verde Islands (lichenized Ascomycotina). *Courier Forschungsinstitut Senckenberg* 159: 153–174.
- Mies BA, Lösch R. 1995. Relative habitat constancy of lichens on the Atlantic islands. *Cryptogamic Botany* 5: 192–198.
- Paz-Bermúdez G, López de Silanes ME. 1998. *Bactrospora carneopallida*, new to Europe. *Lichenologist* 30: 291–292.
- Purvis OW, Coppins BJ, Hawksworth D L, James PW, Moore DM. 1992. The Lichen Flora of Great Britain and Ireland. London, Natural History Museum Publications.
- Scheidegger C. 1993. A revision of European saxicolous species of the genus *Buellia* De Not. and formerly included genera. *Lichenologist* 25: 315–364.
- Sérusiaux E. 1996. Foliicolous lichens from Madeira, with the description of a new genus and two new species and a world-wide key of foliicolous *Fellhanera*. *Lichenologist* 28: 197–227.
- Timdal E. 1992. A monograph of the genus *Toninia* (Lecideaceae, Ascomycetes). *Opera Botanica* 110: 1–137.
- Topham P, Walker FJ. 1982. Field meeting in Tenerife, Canary Islands. New and interesting records. *Lichenologist* 14: 61–75.
- van den Boom PPG, Etayo J. 2006. New records of lichens and lichen lichenicolous fungi from Fuerteventura (Canary Islands), with descriptions of some new species. *Cryptogamie Mycologie*. 27: 341–374.
- Vanderpoorten A, Rumsey FJ, Carine MA. 2007. Does Macaronesia exist? Conflicting signals in the bryophyte and pteridophyte floras. *American Journal of Botany* 94: 625–639.

Lichens from the Amasya, Çorum, and Tokat regions of Turkey

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Abstract — A total of 209 taxa were identified from 20 sampling stations in the Turkish provinces of Amasya, Çorum, and Tokat. 165 taxa are reported as new from Tokat, 63 for Amasya and 56 for Çorum. Three taxa, *Leptorhaphis parameca*, *Ramalina pontica*, and *Seiophora contortuplicata*, are newly recorded for Turkey. For each taxon, habitat and distributional data are presented. The complete checklist is available on <http://www.mycotaxon.com/resources/weblists.html>

Key Words — biodiversity, lichenized fungi, biota, new records

Introduction

An increasing number of studies on the lichen biota of Turkey have been carried out in the last decade (Aslan et al. 2002, Candan & Özdemir Türk 2008, Güvenç et al. 2006, Halıcı et al. 2007, John et al. 2000, John & Breuss 2004, Kinalioğlu 2008, Oran & Öztürk 2006, Tufan et al. 2005). Nevertheless, large gaps remain in the knowledge of lichen distribution in Turkey. Among the particularly neglected areas are Amasya, Çorum, and Tokat. Few publications report any lichens for Amasya or Çorum (John 1999, 2000, John et al. 2000, Çobanoğlu & Akdemir 2004, Leuckert & Kümmerling 1991, Lumbsch & Feige 1999, Steiner 1916, Versegny 1982). For Tokat no published lichen records seem to exist so far. Here data are contributed from Amasya, Çorum, and Tokat, situated in the central part of the Black Sea region of Turkey (FIG. 1), based on collections from 20 sites visited on 5 October 2007 and 1 January 2008. TABLE 1 shows descriptions of Amasya, Çorum, and Tokat provinces.

Materials and methods

The collections were identified with various lichen guides (Brodo et al. 2001, Purvis et al. 1992, Wasser & Nevo 2005, Wirth 1995). Air-dried samples were examined using a stereomicroscope and a light microscope. Vouchers are deposited in the herbarium of the Faculty of Science and Arts, Giresun University, Giresun, Turkey; duplicates of some specimens studied by Etayo and Sipman in herb. Etayo and B, respectively.

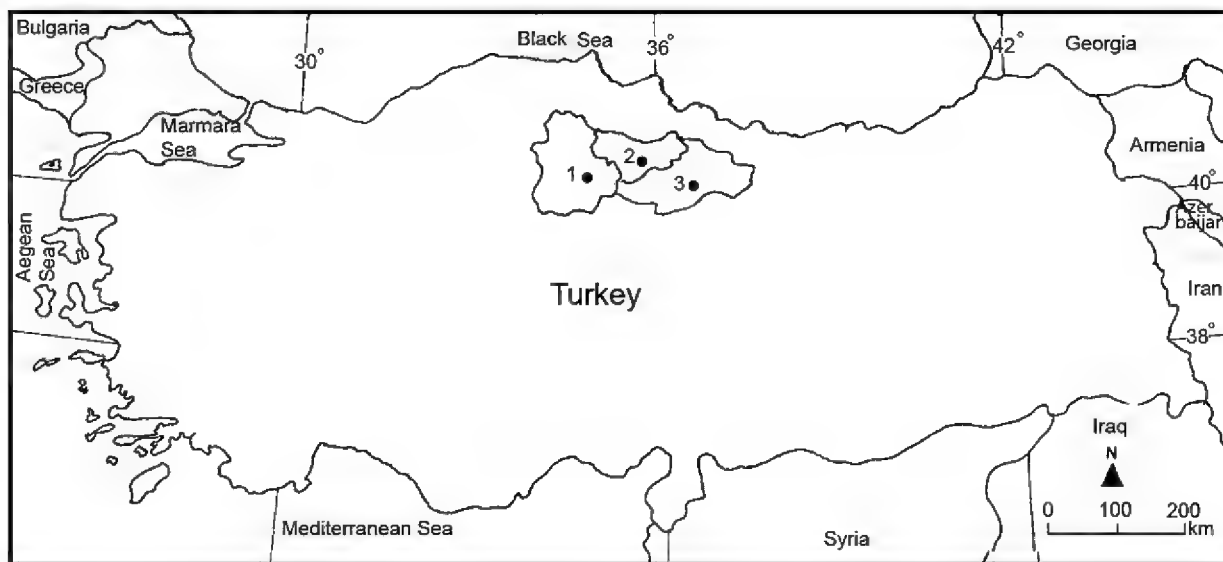


FIG. 1. Provinces from which the samples are collected: 1. Çorum, 2. Amasya, 3. Tokat.

Results and discussion

The list contains three species that are newly recorded for Turkey: *Leptorhaphis parameca*, *Ramalina pontica*, and *Seiophora contortuplicata*. *Leptorhaphis parameca* is an inconspicuous, doubtfully lichenized species known from various sites in Europe and North America (Nimis 1993) that has probably been overlooked so far in Turkey. *Ramalina pontica* is known so far only from the type locality in Romania (Vězda 1975), and its discovery in Turkey supports the hypothesis that it is an endemic from the Black Sea region, as its name suggests. Remarkably the locality is rather far from the coast. By TLC usnic and evernic acids were found (Sipman, pers. comm.). *Seiophora contortuplicata* is a rather widespread, small-foliose lichen of sunny vertical rock faces in the southern European mountains, which extends to Central Asia (Nimis 1993). It was recently reported from Iran (Seaward et al. 2008) and is probably widespread in the mountains of Turkey.

Among the further reported species, *Diploschistes candidissimus*, *Lecanora laatokkaensis*, *L. sambuci*, *Opegrapha herbarum* and *Staurolemma omphalarioides* have rarely been recorded in Turkey until now. *Diploschistes candidissimus* is known throughout Southern Europe, Asia (Egypt, India, Israel), North America, Africa, and Australia (Wasser & Nevo 2005). In Turkey, it was previously recorded only from Trabzon (John & Breuss 2004). *Lecanora laatokkaensis* (after Nimis 1993) is a widespread, but rather small and easily overlooked, lichen in the northern hemisphere. In Europe it is found mainly in the Mediterranean mountains but also in Karelia. In Turkey, *L. laatokkaensis* was previously recorded from Elazığ, Malatya (Candan & Özdemir Türk 2008). *Lecanora sambuci* is known from Europe and North America (Purvis et al. 1992). In Turkey, it was previously recorded from Bursa (Oran & Öztürk 2006, Güvenç et al. 2006) and Uşak (Kınalıoğlu 2008). *Opegrapha herbarum* is rather

TABLE 1. Descriptions of Amasya, Çorum and Tokat provinces.

	AMASYA	TOKAT	ÇORUM
AREA	5690 km ²	9958 km ²	12,820 km ²
ALTITUDINAL RANGE	190–2062 m	188–2385 m	200–2097 m
CLIMATE (Mediterranean)	semi-arid, cold	semi-arid, cold	semi-arid, very cold
ANNUAL RAINFALL	430.8 mm	442.9 mm	420.7 mm
WARMEST MONTH	August (30.4°C)	August (28.5°C)	July (28.7°C)
COLDEST MONTH	January (–0.6°C)	January (–0.4°C)	January (–4.2°C)
DOMINANT VEGETATION	<i>Pinus</i> , <i>Quercus</i>	<i>Abies</i> , <i>Carpinus</i> , <i>Quercus</i> , <i>Pinus</i> , <i>Populus</i>	steppe, <i>Quercus</i> , <i>Pinus</i>
GEOLOGICAL COMPOSITION	Cretaceous, Jurassic, Neogene, Holocene	Holocene, Eocene	Holocene, Permian, Mesozoic

widespread in Europe, Australia, and North America (Purvis et al. 1992), while in Turkey it was previously recorded only from Bursa (Oran & Öztürk 2006) and Zonguldak (Yazıcı 2007). *Physcia wainioi* appears to have also a wide distribution throughout the northern hemisphere but it is not always properly recognized. In Europe it is more common in the Mediterranean (Nimis 1993), a pattern that fits well to its presence in Turkey. In Turkey, *P. wainioi* was previously recorded from Aydın (Nimis & John 1998) and Ordu (John et al. 2000). *Staurolemma omphalarioides* is so far known to have a mediterranean-atlantic distribution in Europe. It is said to be common in Italy (Nimis 1993) and is also reported from the Cape Verde islands. In Turkey, *S. omphalarioides* was previously recorded only from Antalya (Tufan et al. 2005). Its occurrence in Turkey forms a connection to the reported presence in Iran (Seaward et al. 2004).

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Literature cited

Akman Y. 1999. İklim ve Biyoiklim (Biyoiklim Metodları ve Türkiye İklimleri). Palme Yayın Dağıtım, Mühendislik Serisi, Ankara.

Aslan A, Yazıcı K, Karagöz Y. 2002. Lichen flora of Murgul district, Artvin, Turkey. Israel Journal of Plant Sciences 50: 77–81.

Atalay İ. 1994. Türkiye Vegetasyon Coğrafyası. Ege Üniversitesi Basımevi, Bornova, İzmir.

Brodo IM, Sharnoff SD, Sharnoff S. 2001. Lichens of North America, Yale University Press, London.

- Candan M, Özdemir Türk A. 2008. Lichens of Malatya, Elazığ and Adıyaman provinces (Turkey). *Mycotaxon* 105: 19–22.
- Çobanoğlu G, Akdemir B. 2004. Contribution to the lichen flora of Natural Parks in Bolu and Çorum, Turkey. *Herzogia* 17: 137–156.
- Emberger L. 1955. Une classification biogéographique des climats. Recueil des Travaux du Laboratoire de Botanique, Géologie et Zoologie de la Faculté des Science de l'Université de Montpellier, série Botanique 7: 3–43.
- Güvenç Ş, Öztürk Ş, Aydın S. 2006. Contributions to the lichen flora of Kastamonu and Sinop Provinces in Turkey. *Nova Hedwigia* 83(1–2): 67–98.
- Halıcı MG, Candan M, Özdemir Türk, A. 2007. New records of lichenicolous and lichenized fungi from Turkey. *Mycotaxon* 100: 255–260.
- John V. 1999. Lichenes Anatolici Exsiccati. Fasc. 1–3 (No: 1–75), *Arnoldia* 16: 1–41.
- John V. 2000. Lichenes Anatolici Exsiccati. Fasc. 4–5 (No: 76–125), *Arnoldia* 19: 1–27.
- John V, Seaward MRD, Beatty JW. 2000. A neglected Lichen Collection from Turkey: Berkhamsted School Expedition 1971. *Turk J. Bot.* 24: 239–248.
- John V, Breuss O. 2004. Flechten der östlichen Schwarzmeer-Region in der Türkei (BLAM Exkursion 1997). *Herzogia* 17: 137–156.
- Ketin İ. 1961. 1/500.000 Ölçekli Türkiye Jeoloji haritası Sinop Paftası, Ankara, MTA yayınları.
- Kınalıoğlu K. 2008. Floristic lichen records from Uşak Province, Turkey. *International Journal of Botany* 4(4): 444–449.
- Leuckert C, Kümmerling H. 1991. Chemotaxonomische Studien in der Gattung *Leproloma* Nyl. ex Crombie (Lichens). *Nova Hedwigia* 52(1–2): 17–2.
- Lumbsch HT, Feige GB. 1999. Lecanoroid Lichens. Fascicle 5 (No. 81–100), Essen.
- Nimis PL. 1993. The Lichens of Italy. Museo Regionale di Scienze Naturali, Torino.
- Nimis PL, John V. 1998. A Contribution to the Lichen Flora of Mediterranean Turkey. *Cryptogamie, Bryol. Lichénol.* 19(1): 35–38.
- Oran S, Öztürk Ş. 2006. Lichens of Gemlik, İznik, Mudanya and Orhangazi District in Bursa Province (Turkey). *Turk J. Bot.* 30: 231–250.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992. The Lichen Flora of Great Britain and Ireland. Natural History Museum & British Lichen Society, London.
- Seaward MRD, Sipman HJM, Schultz M, Maassoumi AA, Anbaran MH, Sohrabi M. 2004. A preliminary lichen checklist for Iran. *Willdenowia* 34: 543–576.
- Seaward MRD, Sipman HJM, Sohrabi M. 2008. A revised checklist of lichenized, lichenicolous and allied fungi for Iran. Eine revidierte Checkliste der lichenisierten, lichenicolen und verwandten Pilze für Iran. *Sauteria* 15: 459–520.
- Steiner J. 1916. Aufzählung der von J. Börmüller im Oriente gesammelten Flechten. *Anal. Naturhist. Mus.* 30: 24–39.
- Tufan Ö, Sümbül H, Özdemir Türk A. 2005. The lichen flora of the Termessos National Park in Southwestern Turkey. *Mycotaxon* 94: 43–46.
- Verseghy KP. 1982. Beiträge zur Kenntnis der Türkischen Flechtenflora. *Studia Botanica Hungarica* 16: 53–65.
- Vězda A. 1975. Lichenes novi quorum isotypi in fasciculo quinquagesimo tertio collectionis “Lichenes Selecti Exsiccati” distribuentur. *Folia Geobot. Phytotax.* [Praha] 10: 325–327.
- Wasser SP, Nevo E. 2005. Lichen-forming, Lichenicolous, and Allied Fungi of Israel. International Center for Cryptogamic Plants and Fungi, Institute of Evolution, University of Haifa, Israel.
- Wirth V. 1995. Die Flechten Baden-Württembergs. Ulmer, Stuttgart.
- Yazıcı K, Aptroot A, Aslan A. 2007. Lichen biota of Zonguldak, Turkey. *Mycotaxon* 102: 257–260.

***Mycena variicystis*, a new spinose species from Phru Toh Daeng Peat Swamp in Thailand**

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Abstract — *Mycena variicystis* is described as a new species collected from a peat swamp forest at Chaloe Phrakiat Somdet Phra Thep Wildlife Sanctuary-Phru Toh Daeng Peat Swamp in southern Thailand. A comprehensive description and illustrations are provided.

Key words — taxonomy, Basidiomycota, Mycenaceae

Introduction

Eleven spinose species of *Mycena* were reported worldwide by Desjardin et al. (2002) and accepted as members of *Mycena* section *Longisetae*. They were tentatively placed in two stirps: stirps *Brunneisetosa*, including *M. brunneisetosa* Corner, *M. indica* Manim. & Leelav., and *M. tenuisetosa* Corner, *M. trichocephala* Singer and stirps *Longiseta*, including *M. aciculata* (A.H. Sm.) Desjardin & E. Horak, *M. breviseta* Höhn., *M. brevisetosa* Corner, *M. clavulifera* (Berk. & Broome) Sacc., *M. khonkhem* Desjardin et al., *M. longiseta* Höhn., and *M. palmicola* Desjardin et al. *Mycena palmicola* and *M. khonkhem* were described as new while *M. clavulifera* was redescribed based on material collected in Thailand. During the course of preparing a monograph of spinose species of *Mycena* from Southeast Asia, one new species was discovered in Thailand that is described formally below. The new species is characterized by cheilocystidia with few, long, apical appendages (unique in the section), thin-walled and non exudative pileocystidia, and an absence of caulocystidia.

Material and Methods

All measurements and colours reported for microscopic feature were made from dried material, rehydrated in 100% ethanol followed by distilled water,

3% KOH or Melzer's reagent. Spore statistics include: \bar{x} , the arithmetic mean of the spore length by spore width (\pm SD) for n spores measured in a single sample (specimen); Q , the quotient of spore length and spore width in any one spore, indicated as a range of variation in n spores measured; Q_m the mean of Q values where more than one specimen was available.

Taxonomy

Mycena variicystis Boonprat., sp. nov.

FIGS. 1–6

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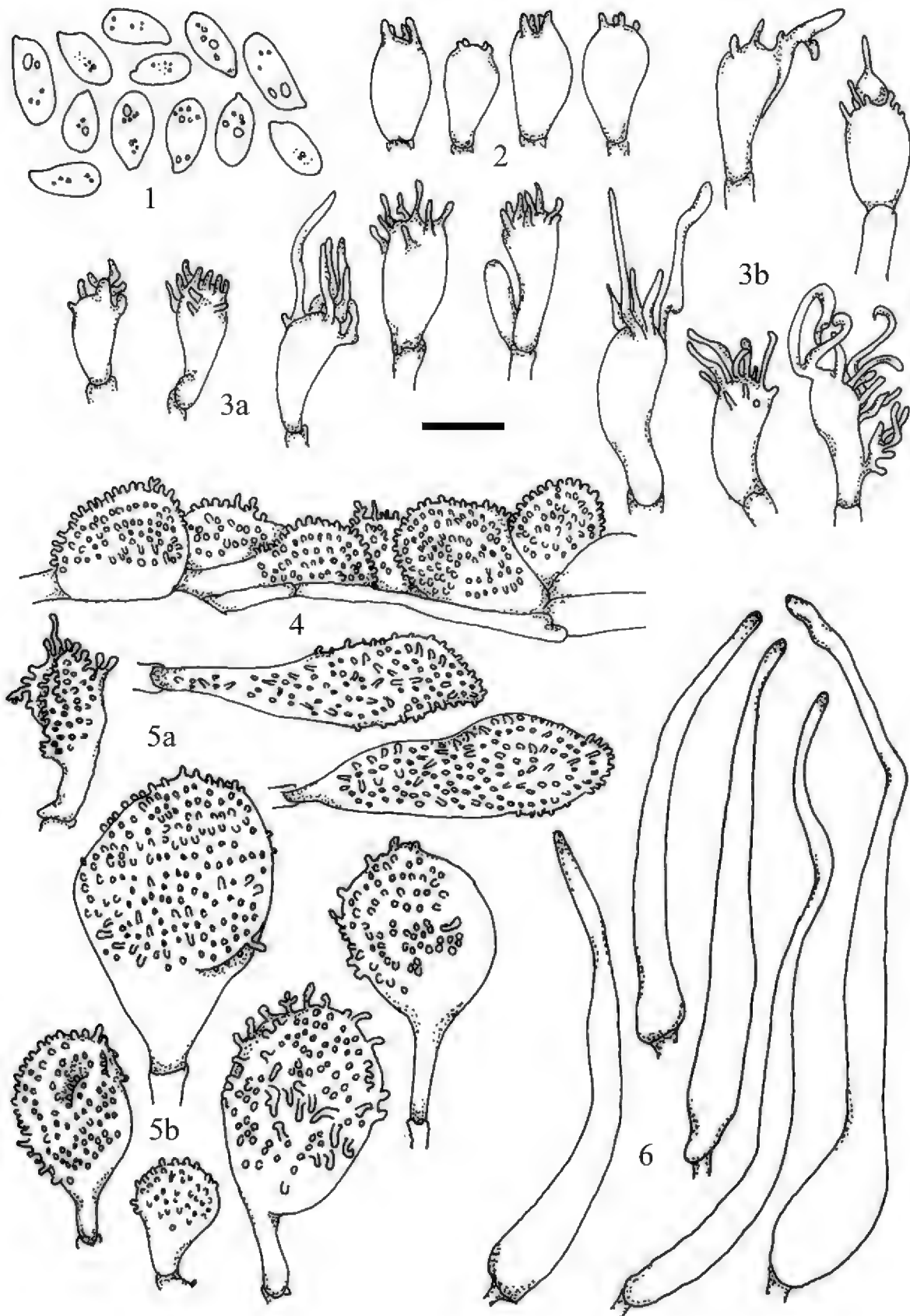
Pileus 1.0–4.5 mm, *convexus dein plano-convexus, striatus, albidus, brunneolus centro, hispidulus*. *Lamellae adnatae, angustae collariatae, distantes, latae, albae*. *Stipes* 5.0–15.0 \times 0.2 mm, *ubique albus, ad basim pruinoso-discoideus*. *Basidiosporae* 8–12(–15) \times 4–5.6 μ m, *ellipsoideae, leves, hyalinae, amyloideae*. *Basidia* 4-spora, *clavata*. *Basidiola clavata*. *Pleurocystidia nulla*. *Cheilocystidia* 20–30(–35) \times (5–)7–11 μ m, *clavata, apicalis appendix, hyalinae, inamyloideae; appendiculae* 4–12 \times 1–1.5 μ m, *irregularis appendix, cylindricus*. *Hyphae pileipellis* 8–15 μ m *latae, cylindraceae, haud gelatinosae, spinulosus; cellulae apicales ex acanthocystis* 20–35 \times 10–30 μ m, *late clavatis vel sphaeropedunculatis, spinulosi*. *Spinulae cylindraceae* 0.5–2.5 \times 0.5–1 μ m *dense instructae*. *Pileocystidia* 56–92 \times 4–10 μ m, *ex clavata, aciculalis, late basis, tenuitunicatis*. *Trama pilei* 7–20 μ m *latae, cylindraceae, haud gelatinosae, hyalinae, dextrinoidae, haud gelatinosae*. *Trama hyphae et corticales tipitis lamellarum ex hyphis dextrinoideis compositum, haud gelatinosae*. *Caulocystidia nulla*. *Ad folia dejecta. Thailandia. Holotypus: BBH1888*.

ETYMOLOGY – *varie-* (Latin) = variously; *-cystis* (Latin) = cell; referring to the various types of cystidia present in the species.

TYPE – THAILAND, Narathiwat, Chaloem Phrakiat Somdet Phra Thap Wildlife Sanctuary-Phru Toh Daeng Peat Swamp, trail along the wood bridge, 14 Feb. 2001, T. Boonpratuang 176 (Holotype: BBH1888; Isotype: SFSU).

Pileus 1.0–4.5 mm diam., convex to plano-convex with a flattened disc, margin inflexed, striate; surface dry, rugulose, hispid; disc pale brown, margin cream-coloured. Context < 0.5 mm thick. Odor not distinctive; taste unknown. *Lamellae* adnate to a pseudocollarium, distant (10–12) with 2 series of lamellulae, broad, thin, white. *Stipe* 5.0–15.0 \times 0.2 mm, central, cylindrical, equal, arising from a small basal disc, fragile, dry, glabrous, white to cream-coloured.

Basidiospores (FIG. 1) 8–12(–15) \times 4–5.6(–7) μ m [\bar{x} = 9.0 \pm 0.9 \times 4.4 \pm 0.5 μ m, Q = 1.4–3, Q_m = 2.08 \pm 0.11; n = 25 spores], ellipsoid, smooth, hyaline, distinctly amyloid, thin-walled. *Basidia* (FIG. 2) 18–20 \times 10–15 μ m, broadly clavate, 4-sterigmate. *Basidioles* clavate. *Pleurocystidia* absent. *Cheilocystidia* (FIG. 3a–b) abundant, *lamellae* edge sterile, 20–30(–35) \times (5–)7–11 μ m, clavate, with few to numerous apical appendages, hyaline to pale yellow, inamyloid, thin-walled; apical appendages 4–12 \times 1–1.5 μ m, irregularly cylindrical. *Pileipellis* (FIG. 4) a hymeniform layer of acanthocysts when young, becoming a cutis of repent hyphae with acanthocyst terminal cells in age, with scattered pileocystidia; hyphae 8–15 μ m diam, densely spinulose, hyaline,



FIGURES 1–6 *Mycena variicystis*, holotype BBH1888.

1. Basidiospores, 2. Basidia, 3a–b. Cheilocystidia, 4. Pileipellis with acanthocysts, 5a–b. Acanthocysts, 6. Pileocystidia. Bar = 10 μ m.

inamyloid, thin-walled, non-gelatinous. Acanthocysts (FIG. 5a–b) $20\text{--}35 \times 10\text{--}30 \mu\text{m}$, broadly clavate to sphaeropedunculate, densely spinulose, hyaline to pale yellowish brown, inamyloid, thin-walled; spinulae $0.5\text{--}2.5 \times 0.5\text{--}1 \mu\text{m}$, cylindrical. Pileocystidia (FIG. 6) scattered, simple, $56\text{--}92 \times 4\text{--}10 \mu\text{m}$, acicular, often with an enlarged base and gradually narrowed upwards to an acute apex, smooth, hyaline, inamyloid, thin-walled. Hypodermium not differentiated. Pileus trama composed of loosely arranged hyphae $7\text{--}20 \mu\text{m}$ diam., cylindrical, smooth, hyaline, strongly dextrinoid, non-gelatinous. Lamellar trama hyphae dextrinoid. Stipitipellis a cutis of repent hyphae. Stipe tissue monomitic; cortical and medullary hyphae parallel, cylindrical, hyaline, strongly dextrinoid, thin-walled, non-gelatinous. Caulocystidia absent. Clamp connections present but not at every septum.

HABIT, HABITAT AND KNOWN DISTRIBUTION. Solitary to scattered, lignicolous on bark of undetermined dicotyledonous tree in mixed forest. Thailand..

COMMENTARY: *Mycena variicystis* is the only known spinose *Mycena* species with cheilocystidia that have few, long apical appendages. Eleven species in sect. *Longisetae* lack cheilocystidia, while most others have cheilocystidia covered with short, rod-like spinulae. The thin-walled pileocystidia are also unusual in sect. *Longisetae*, suggesting that the new species may belong elsewhere in *Mycena*. However there is no existing section of *Mycena* that would accommodate a species with its unusual combination of characters. Thus, in the interim, the best solution is to include it as a tentative member of sect. *Longisetae* until more information is obtained.

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Literature cited

Desjardin DE, Boonpratuang T, Hywel-Jones NL. 2002. An accounting of the worldwide members of *Mycena* sect. *Longisetae*. Fungal Diversity 11: 69–85.

Notes on *Tuber huidongense* (Tuberaceae, Ascomycota), an endemic species from China

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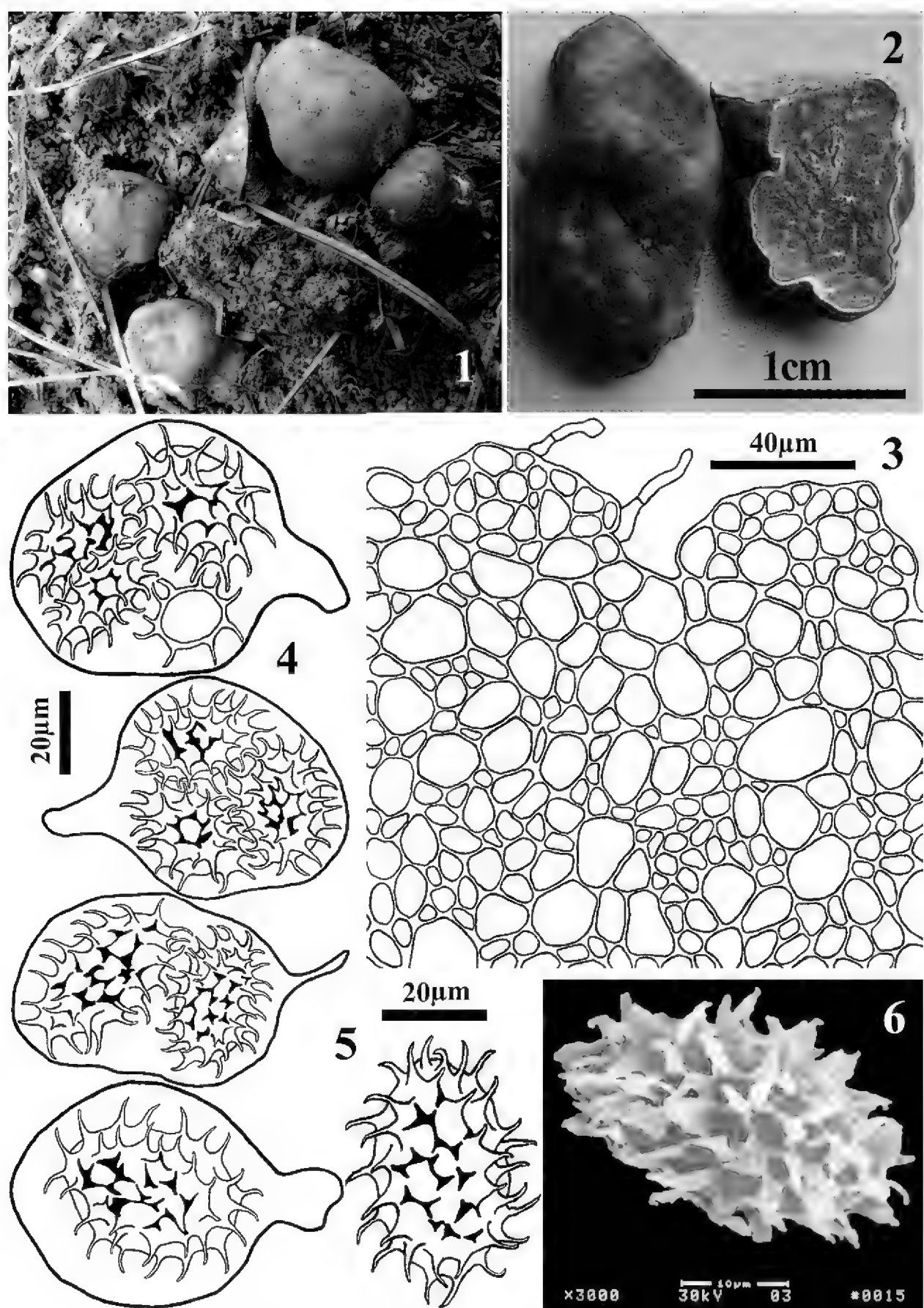
Abstract — Based on material collected from Yunnan and Sichuan, China, *Tuber huidongense* is re-described and illustrated in detail. A key to distinguish *T. huidongense* and its allied species found in China is provided. *T. furfuraceum* is synonymized with *T. huidongense*. Molecular phylogenetic analysis using ITS-rDNA sequences demonstrated that *T. huidongense* is a well-supported species in the *T. rufum*-clade. Morphological characters of *Tuber huidongense* × *Pinus armandii* mycorrhizae are also illustrated and described for the first time.

Key words — truffle, taxonomy, morphology

Introduction

Taxonomic study of the genus *Tuber* in China began with the description of *T. taiyuanense* B. Liu in the 1980s (Liu 1985). Over the last two decades a total of thirteen new species were described from China (Zhang & Minter 1988, Tao & Liu 1989, Wang & Li 1991, Hu 1992, Moreno et al. 1997, Wang et al. 1998, Xu 1999, Wang & He 2002, He et al. 2004, Chen et al. 2005, Hu & Wang 2005, Chen & Liu 2007). Among them, *T. huidongense*, *T. liaotongense* Y. Wang, *T. taiyuanense*, *T. umbilicatum* Juan Chen & P.G. Liu, and *T. furfuraceum* are five taxa that resemble each other. The phylogenetic work by Wang et al. (2007) indicated that *T. huidongense*, *T. taiyuanense*, and *T. liaotongense* clustered in the *T. rufum* group. However, morphological characters of *T. huidongense* were not fully documented and its relation with other species, such as *T. furfuraceum*,

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FIGS. 1–6: *Tubera huidongense*. 1. Ascomata in natural habitat; 2. Dried ascomata; 3. Pseudoparenchymatous tissue of outer layer of peridium with outer peridial hyphae; 4. Asci and ascospores; 5. Line drawing of an ascospore; 6. SEM photomicrograph of an ascospore.

remained unclear. Additional *Tuber huidongense* specimens collected from Yunnan and Sichuan Province, China, made it possible to examine it in depth and reveal the morphological variation among individuals. Mycorrhizae, which were traced to ascomata of *T. huidongense* in a forest of *Pinus armandii* Franch., were confirmed by ITS sequence comparison and their morphological characters are reported herein.

Materials and methods

Macroscopic characters are described from fresh or dried materials, while microscopic characters are based on the dried material. Sections of tissue were made with a razor blade and mounted in 5% KOH. Line drawings were made with a Nikon E400 microscope and the aid of a drawing tube. Scanning electron microscopy (SEM) followed Chen et al. (2005). Statistical analysis of spore measurements followed Yang (2000). Specimens examined were deposited in the Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences (KUN-HKAS) and Herbarium of Forestry Department, National Taiwan University, Taipei, Taiwan, China (NTUF).

Samples of mycorrhizae were collected beneath an ascomata of collection KUN-HKAS 55305 in Xiangyun County (Central Yunnan, China). The procedure for preparing samples of mycorrhizae for observation followed Agerer (1987–2006). Samples of mycorrhizae were examined with a Leica S8APO stereoscope. Cross-sections of mycorrhizae were made with a Leica CM1100 freezing microtome. The macro- and microscopic characters of mycorrhizae are described and illustrated according to Agerer (1987–2006).

DNA was extracted from samples using modified CTAB (Doyle 1987). The primers ITS5 (White 1990) and ITS4LNG (Paolocci et al. 1999) were used to amplify the ITS region of the DNA from ascomata and mycorrhizae. The primers Nad3-1 and Nad3-2 (Soranzo 1999) were used to amplify the mitochondrion gene of host plant in mycorrhizae. PCR reaction solution and cycling parameters in Chen & Liu (2007) were used with necessary modification. PCR reaction was performed on a Takara TP100 thermal cycler. Amplification products were electrophoresed on a 1% agarose gel, and purified with Sangon's purification kit. Sequencing was performed with a BigDye® Terminator v3.1 Cycle Sequencing Kit on an ABI 3730XL automatic sequencer. Software and methods used in sequence alignment and phylogenetic analysis followed Chen & Liu (2007).

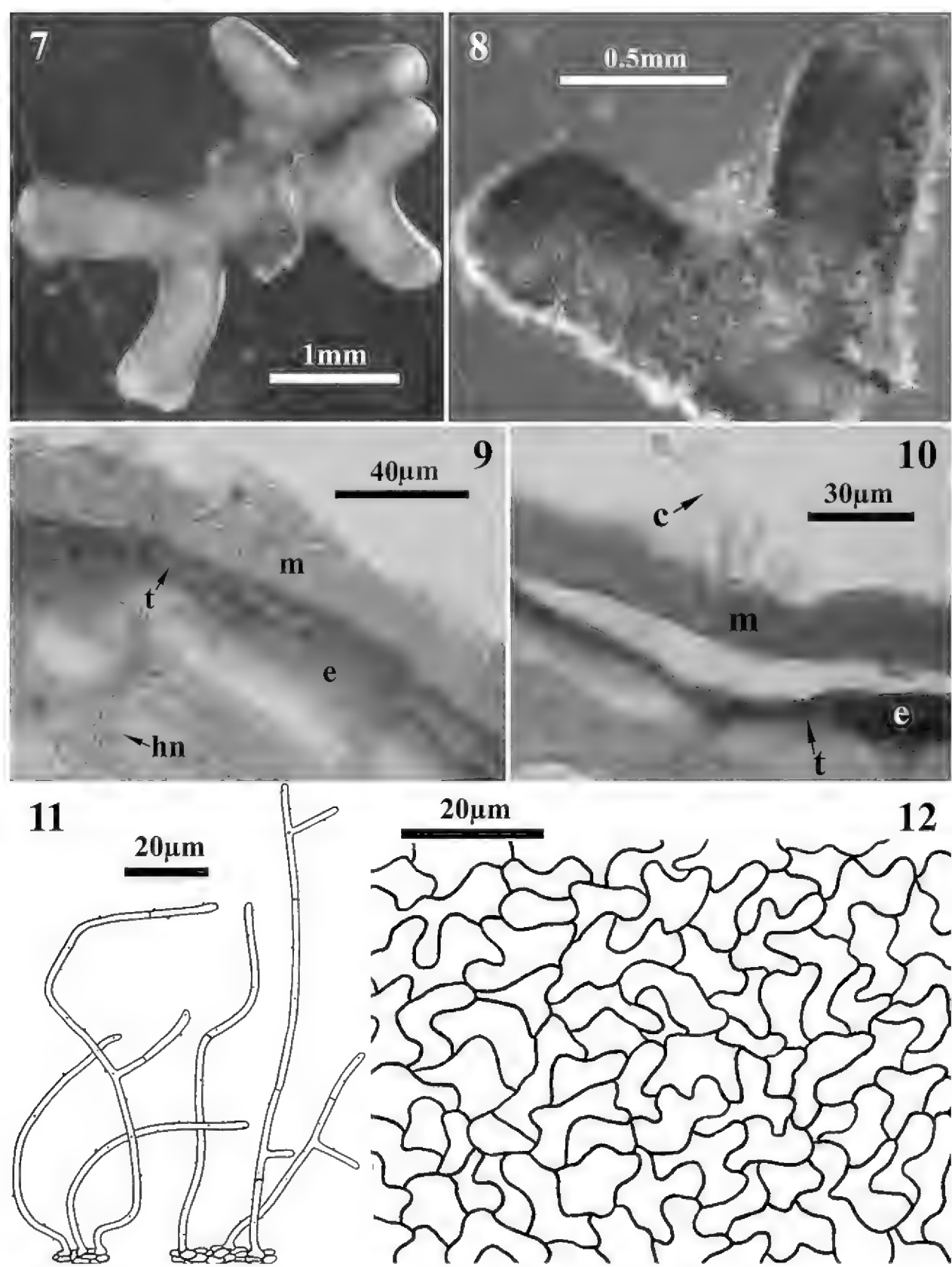
Results

Morphology of ascomata

FIGS. 1–6

Tuber huidongense Y. Wang, Mycotaxon 83: 191 (2002).

= *Tuber furfuraceum* H.T. Hu & Y. Wang, Mycotaxon 93: 155 (2005).



FIGS. 7–12: Mycorrhizae formed by *T. huidongense* on *P. armandii*. 7. Bifurcate mycorrhizal roots; 8. Mycorrhizal root tips with emanating hyphae; 9, 10. Cross section of mycorrhizae, cystidia (c), epidermis (e), hn (Hartig net), mantle (m), tannins (t); 11. Emanating hyphae; 12. Pseudoparenchymatic structure of outer mantle layer.

Ascomata subglobose, irregularly globose, ellipsoid, furrowed slightly or irregularly, 0.5–2.5 cm in diam; surface yellow-brown to red-brown when fresh, brown when dried, under stereoscope verrucose or slightly furfuraceous, pubescent or not, pubescence more visible when fresh. Gleba whitish when young, brown to nearly black when mature, marbled with pale to light brown veins (FIGS. 1, 2).

Peridium 150–300 µm thick (excluding verrucae, which are 10–50 µm tall), composed of two layers: outer layer 80–150 µm thick, pseudoparenchymatous, composed of subglobose or subangular yellow-brown cells, 4–30 × 4–21 µm, cell walls 2–3 µm thick; inner layer 90–150 µm thick, composed of intricately interwoven, thin-walled hyphae 1–5 µm diam; outer peridial hyphae pale yellow-brown, cylindrical, sometimes with inflated ends, 15–30 µm long, 3–5 µm in diam, not septate or with one septum, originating from superficial cells (FIG. 3). Asci 42–70 × 35–55 µm excluding stalk, ellipsoid or subglobose, stalk measuring 8–25 × 6–14 µm, 1–4(–5) spored (FIG. 4). Ascospores ellipsoid to narrowly ellipsoid, spiny-reticulate, yellowish brown at maturity; in 1-spored asci 25–44(–45) × (19–)20–28 µm, 2-spored asci 25–40 × (16–)18–24(–28) µm, 3-spored asci (25–)27–35(–38) × (17–)18–22(–29) µm, 4-spored asci (22–)25–38(–40) × 16–21(–27) µm; $Q = (1.10\text{--})1.25\text{--}1.80(–2.24)$, $Q = 1.50 \pm 0.18$ (200/10/5); spines 4–6(–7) µm high, some curving at apex; meshes 4–9 × 3–8 µm, some incomplete, 3–5 across the spore width and 4–6 along the spore length; walls 2 µm thick (FIG. 5, 6).

HABITAT AND DISTRIBUTION: under *P. armandii*-dominated forests mixed with *Betula alnoides* Buch.-Ham. ex D. Don, *Myrsine africana* L., and *Cotoneaster franchetii* Bois, or under *Cyclobalanopsis glauca* Oerst.

SPECIMENS EXAMINED: CHINA. SICHUAN PROVINCE: Huidong Co., Jiangzhou (E102°47', N26°56'), Minde village, in *P. armandii* forest, alt. 2070 m, 26 Nov. 1989, Y. Wang 89923 (IFS89923-Holotype); Huidong Co. (E102°58', N 26°63'), wild edible mushroom market, 3 Nov. 2006, J. Chen 410 (KUN-HKAS 52008), J. Chen 419 (KUN-HKAS 52015); Huili Co. (E102°24', N26°66'), wild edible mushroom market, 6 Nov. 2006, J. Chen 420 (KUN-HKAS 52016). YUNNAN PROVINCE: Kunming City, Shuanglong, Jiulongwan, Erdanshishan (E102°48.394', N25°09.928'), in *P. armandii* and *Betula alnoides* mixed forest, alt. 2260 m, 10 Nov. 2007, X. J. Deng JD-03 (KUN-HKAS 55304); Xiangyun Co., 320 national highway, toll station (E100°32.043', N25°26.943'), in mixed forest dominated by *P. armandii*, *Myrsine africana*, and *Cotoneaster franchetii*, alt. 1950 m, 2 Dec. 2007, X. J. Deng XY-03 (KUN-HKAS 55305). TAIWAN: Nan-tou Co., under *Cyclobalanopsis glauca*, alt. 1200m, Dec. 2002, H. T. Hu 0201 (Holotype of *T. furfuraceum*, in NTUF).

Morphology of mycorrhizae of *T. huidongense* × *P. armandii*

FIGS. 7–12

Mycorrhizal system mostly bifurcate, rarely unramified, 1–3.5 mm long, with 1–3 orders of ramifications; short-distance exploration type. Main axes 0.4–0.5 mm, slightly bent. Unramified ends straight, dark brown in older

parts, brownish in young parts and often whitish to pale brown at the apex, cylindrical and with a rounded apex, 0.5–1 mm long and 0.4–0.6 mm in diam; cortical cells not visible; mantle not transparent, with locally darker patches. Emanating hyphae hyaline, loosely woolly, sometimes scattered and distributed unequally. KOH 5%, cotton-blue, and Melzer's reagent reactions not distinctive. Rhizomorphs lacking. Sclerotia lacking.

Mantle 15–25 μm thick, pseudoparenchymatic in cross-section, composed of 6–8 layers of hyphal cells; cells $2\text{--}10 \times 2\text{--}8 \mu\text{m}$, pale yellow-brown, round to elliptical; slightly discernible with different layers; Outer mantle layers pseudoparenchymatic in structure with interlocking epidermal cells arranged in a puzzle-like pattern in plan view [mantle type M in Agerer (1987–2006)]; cells $10\text{--}18 \times 5\text{--}10 \mu\text{m}$, thin-walled. Emanating hyphae cylindrical, thin-walled, bent and septate, 70–150 μm long and 2–3 μm in diam, ends rounded; simple or ramified almost perpendicular and a considerable distance from septum, branches 10–40 μm long; surface warty, warts distributed more or less evenly. Cystidia emanating from outer layer of mantle, cylindrical, thin-walled, 15–45 μm long, 5–8 μm in diam. Tannin cells present, $8\text{--}12 \times 10\text{--}15 \mu\text{m}$, red-brown to red, one row. Hartig net composed of 1–2 layers of hyphal cells, two rows thick [Hartig nets type A in Agerer (1987–2006)], cells $1\text{--}3 \times 2\text{--}4 \mu\text{m}$.

Phylogenetic analysis

Twenty-four partial internal transcribed spacer ribosomal DNA (ITS-rDNA) sequences of eleven *Tuber* species (*T. candidum* Harkn., *T. excavatum* Vittad., *T. ferrugineum* Vittad., *T. huidongense*, *T. furfuraceum*, *T. liaotongense*, *T. pseudoexcavatum* Y. Wang et al., *T. quercicola* J.L. Frank et al., *T. rufum* Pico, *T. taiyuanense*, and *T. umbilicatum*) were used for analysis (TABLE 1). *Tuber excavatum* was selected as outgroup. Of the 516 characters analyzed 352 characters were constant, 71 were variable and 93 were parsimony informative. 90 ambiguous characters were excluded from the analyses.

The ITS phylogenetic tree revealed two major well-supported clades. Clade II is composed of *T. pseudoexcavatum*; In clade I *T. liaotongense* (subclade I), *T. huidongense* (subclade II), *T. umbilicatum* (subclade III), and *T. rufum* (subclade IV) formed subclades with high bootstrap support ($\geq 96\%$) respectively. One sample of *T. taiyuanense* and two samples of *T. umbilicatum* formed a subclade with bootstrap support of 71%. Three samples identified as *T. candidum*, *T. ferrugineum*, and *T. quercicola* were also included in clade I (FIG. 13).

Discussion

When originally described, the ascomata of *T. huidongense* were described as “rough with scattered hairs” (Wang & He 2002). However, our careful observation found that some specimens (KUN-HKAS 52016, KUN-HKAS55304) had hairs

on the surface of ascomata and others not. Those collections proved to be conspecific in our phylogenetic tree (FIG. 13). Based on this, we regard this character as inconsistent in *T. huidongense* and it might be affected either by environmental factors or by mechanical friction. Significant variations were also found to exist between individuals in the shape of spores and to numbers of spores per ascus. For example, the spores of KUN-HKAS 55305 had the lowest Q value ($Q = 1.35$) and an extremely high proportion of 1-spored and 2-spored

TABLE 1: Origin of the fungal sequences.

TAXON	CODE	VOUCHER	GEOGRAPHIC ORIGIN	ITS1	ITS2
<i>T. liaotongense</i>	L1	/	Fushun, Liaoning, China	DQ478669	DQ478633
<i>T. liaotongense</i>	L2	/	Inner Mongolia, China	DQ478671	DQ478635
<i>T. liaotongense</i>	L3	/	Inner Mongolia, China	DQ478672	DQ478634
<i>T. huidongense</i>	H1	/	Panzhihua, Sichuan, China	DQ486031	DQ486031
<i>T. huidongense</i>	H2	/	Panzhihua, Sichuan, China	DQ486032	DQ486032
<i>T. huidongense</i>	H3	HKAS 52015	Huidong, Sichuan, China	FJ797882	FJ797882
<i>T. huidongense</i>	H4	HKAS 52008	Huidong, Sichuan, China	FJ797881	FJ797881
<i>T. huidongense</i>	H5	HKAS 52016	Huili, Sichuan, China	FJ797883	FJ797883
<i>T. huidongense</i>	H6	HKAS 55305	Xiangyun, Yunnan, China	FJ797877	FJ797877
<i>T. huidongense</i>	H7	HKAS 55304	Kunming, Yunnan, China	FJ797878	FJ797878
<i>T. furfuraceum</i>	H8	NTUF Holotype	Taibei, Taiwan China	FJ859900	FJ859900
<i>T. taiyuanense</i>	T1	HMAS 60234	Xuanhua, Hubei, China	DQ478664	DQ478650
<i>T. umbilicatum</i>	U1	HKAS 52012	Huidong, Sichuan, China	FJ797879	FJ797879
<i>T. umbilicatum</i>	U2	HKAS 52012	Huidong, Sichuan, China	FJ797880	FJ797880
<i>T. rufum</i>	R1	/	Italy	AY112894	AY112894
<i>T. rufum</i>	R2	/	Italy	AY940646	AY940646
<i>T. quercicola</i>	Q1	/	Oregon, USA	AY918957	AY918957
<i>T. candidum</i>	C1	/	Southern Oregon, USA	AY830856	AY830856
<i>T. ferrugineum</i>	F1	/	/	AF132506	AF132506
<i>T. pseudoexcavatum</i>	P1	HKAS 39504	Chuxiong, Yunnan, China	AY514310	AY514310
<i>T. pseudoexcavatum</i>	P2	/	Huili, Sichuan, China	DQ329368	DQ329368
<i>T. pseudoexcavatum</i>	P3	/	Panzhihua, Sichuan, China	DQ329370	DQ329370
<i>T. excavatum</i>	E1	/	Miskolctapolca, Hungary	AJ557545	AJ557545

asci accounting for 40% and 55% respectively, whereas those of KUN-HKAS 52016 had the highest *Q* value ($Q = 1.63$) and a relatively high proportion of 3-spored and 4-spores asci, 35% and 27% respectively (FIG. 14).

At first glance, *T. huidongense* closely resembles *T. furfuraceum*, a species described from Taiwan by Hu & Wang (2005). They were considered different because *T. furfuraceum* had narrower, more ellipsoid spores [$Q = (1.3-1.7)$ (-2.3)] compared to *T. huidongense* (Hu & Wang 2005). However, such variation falls within the range revealed by the specimens of *T. huidongense* (FIG. 14). The conspecificity is also supported by molecular data (FIG. 13). Hence, we conclude that *T. huidongense* and *T. furfuraceum* are synonyms.

The affinity of *T. huidongense* to *T. borchii* Vittad., *T. maculatum* Vittad., and *T. pseudoexcavatum* as supposed by Wang & He (2002) is not yet supported by phylogenetic analysis of Wang et al. (2007), Jeandroz et al. (2008), or our study (FIG. 13). *Tuber huidongense* belongs to the *T. rufum* group, which contains *T. liaotongense*, *T. taiyuanense* from China, *T. rufum* from Europe, and *T. candidum* and *T. quercicola* from North America (Wang et al. 2007, Jeandroz et al. 2008). Our phylogenetic analysis found another member of this group, *T. umbilicatum* (FIG. 13), which was described from China (Chen et al. 2005). Morphologically *T. huidongense* shares a number of characters with this group, such as ascomata with small verrucose peridia and yellowish colored and spiny-reticulate spores. A key to distinguish the taxa from China in this group is provided.

Key to *T. huidongense* and its allied species from China

1. Ascomata with basal cavity *T. umbilicatum*
1. Ascomata without basal cavity 2
2. Ascomata smooth; spores with 5–8 meshes across width *T. taiyuanense*
2. Ascomata verrucose; spores with 3–5 meshes across width 3
3. Spores ellipsoid to narrowly ellipsoid, $Q \geq 1.35$; spines 4–6(–7) μm tall,
slightly curved at end *T. huidongense*
3. Spores broadly ellipsoid, $Q = 1.28$; spines 2–4 μm tall,
distinctly curved at end *T. liaotongense*

Mycorrhizae of *T. huidongense* \times *P. armandii* are characterized by perpendicularly ramified emanating hyphae with warts and cylindrical cystidia, together with a puzzle-like outer mantle layer. Cystidia and warty emanating hyphae also are found on mycorrhizae formed by *T. borchii* and *T. mesentericum* Vittad., however cystidia of the other two mycorrhizae are awl-shaped (Zambonelli et al. 1993, 1995, 1998; Dunabeitia et al. 1996, Rauscher et al. 1996). Roots of *P. armandii* with *T. indicum* Cooke & Masee, mycorrhizae also have puzzle-like mantle layers with epidermal cells and almost perpendicularly ramified emanating hyphae (result unpublished). However, the surfaces of emanating hyphae of the mycorrhizae formed by *T. indicum* are always smooth.

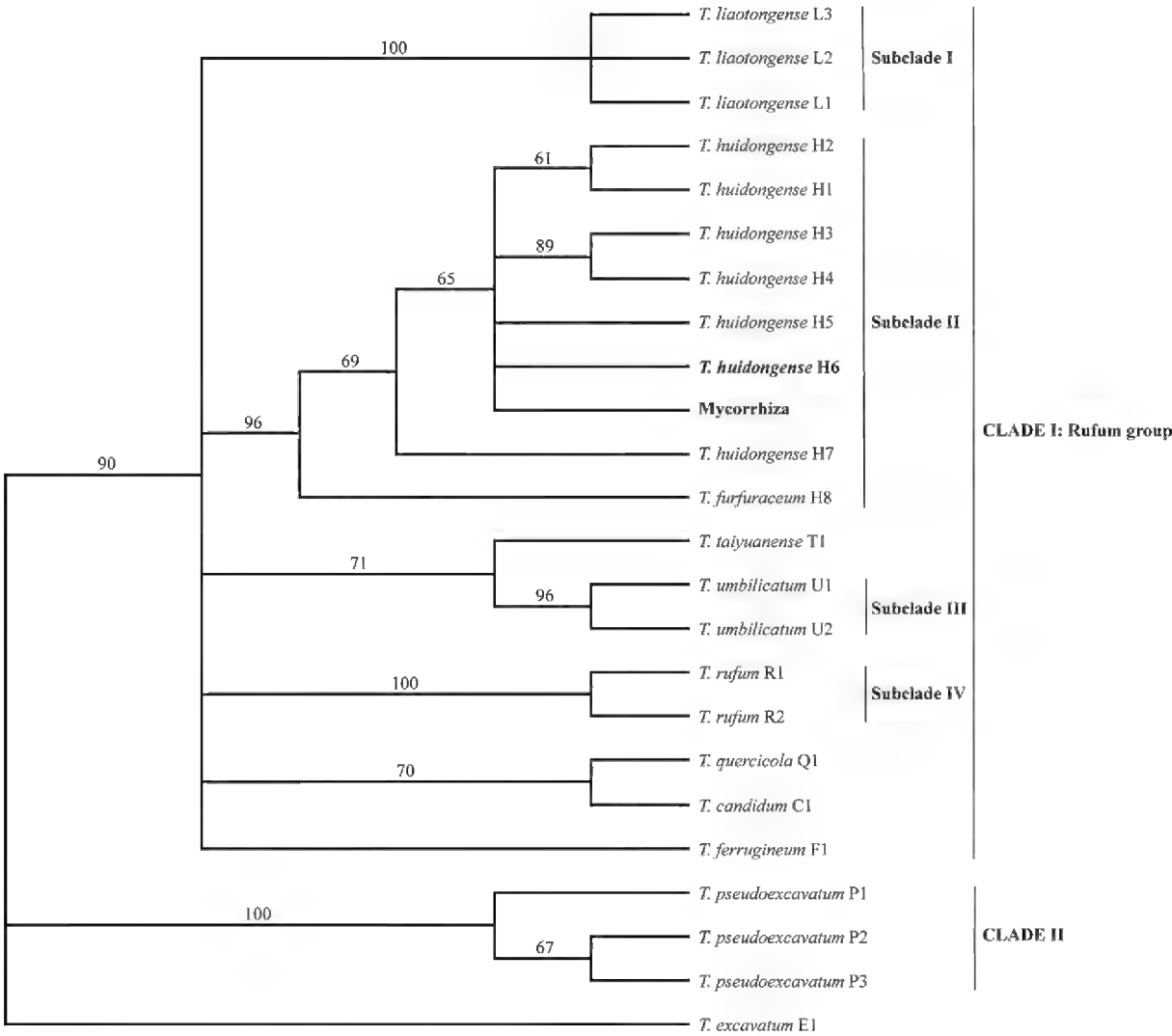


FIG. 13: Maximum parsimony bootstrap consensus tree obtained with ITS1-ITS2 rDNA sequences of *T. huidongense* and related species.

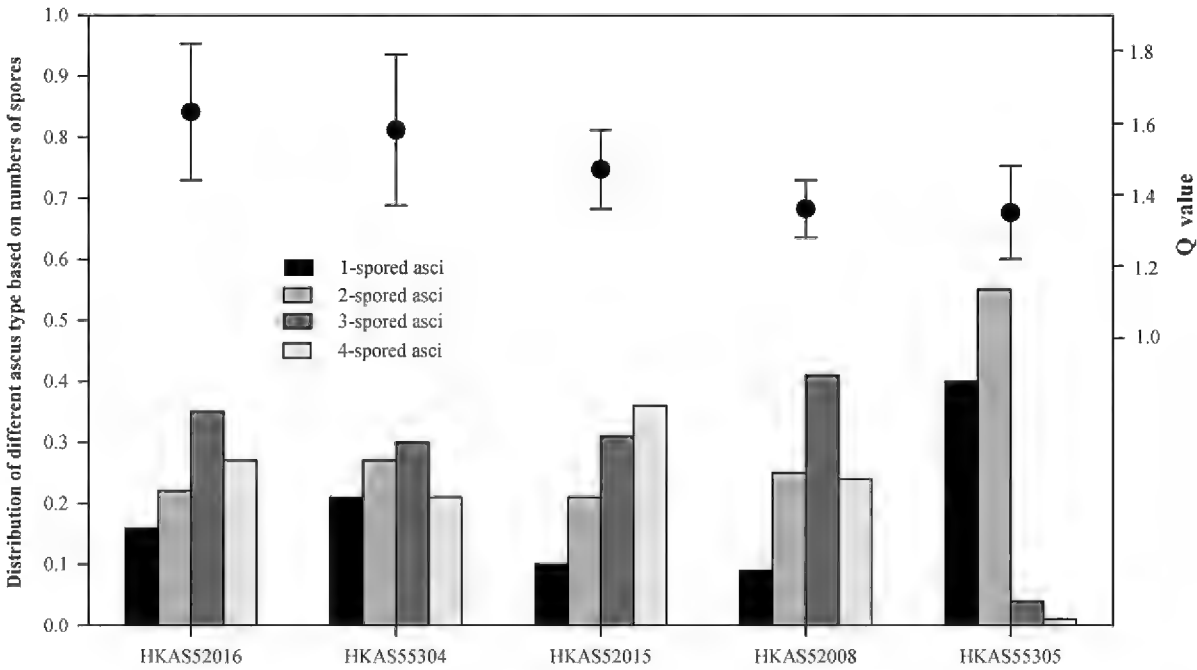


FIG. 14: Q value and distribution of ascus types based on numbers of spores in *T. huidongense*.

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Literature cited

- Agerer R. 1987–2006. Color atlas of ectomycorrhizae: 1st–13th delivery. Einhorn-Verlag, Schwäbisch Gmünd.
- Chen J, Liu PG, Wang Y. 2005. *Tuber umbilicatum*, a new species from China, with a key to spinose-reticulate spored *Tuber* species. Mycotaxon 94: 1–6.
- Chen J, Liu PG. 2007. *Tuber latisporum* sp. nov. and related taxa, based on morphology and DNA sequence data. Mycologia 99: 475–481.
- Doyle JJ, Doyle JL. 1987. A rapid DNA isolation procedure from small quantities of fresh leaf tissues. Phytochem. Bull. 19: 11–15.
- Dunabeitia MK, Hormilla S, Salcedo I, Pena JI. 1996. Ectomycorrhizae synthesized between *Pinus radiata* and eight fungi associated with *Pinus* spp. Mycologia 88: 897–908.
- He XY, Li HM, Wang Y. 2004. *Tuber zhongdianense* sp. nov. from China. Mycotaxon 90: 213–216.
- Hu HT. 1992. *Tuber formosanum* sp. nov. and its mycorrhizal associations. Quart J Exp Forest 6: 79–86.
- Hu HT, Wang Y. 2005. *Tuber furfuraceum* sp. nov. from Taiwan. Mycotaxon 93: 155–157.
- Jeandroz S, Murat C, Wang YJ, Bonfante P, Le Tacon F. 2008. Molecular phylogeny and historical biogeography of the genus *Tuber*, the ‘true truffles’. J. Biogeogr 35: 815–829.
- Liu B. 1985. New species and new records of hypogeous fungi from China (1). Acta Mycol Sinica 4(2): 84–89.
- Moreno G, Manjón JL, Díez J, García Montero LG, Massimo GD. 1997. *Tuber pseudohimalayense* sp. nov. an Asiatic species commercialized in Spain similar to the “Perigord” truffle. Mycotaxon 63: 217–224.
- Rauscher T, Müller WR, Agerer R, Chevalier G. 1996. *Tuber borchii* Vitt. + *Corylus avellana* L. Descr Ectomyc 1: 173–178.
- Paolocci F, Rubini F, Granetti B, Arcioni S. 1999. Rapid molecular approach for a reliable identification of *Tuber* spp. ectomycorrhizae. FEMS Microbiology Ecol 28: 23–30.
- Soranzo N, Provan J, Powell W. 1999. An example of microsatellite length variation in the mitochondrial genome of conifers. Genome 42: 158–161.

- Tao K, Liu B. 1989. A new species of the genus *Tuber* from China. J Shanxi Univ 12: 215–218.
- Wang Y, Li ZP. 1991. A new species of the genus *Tuber* from China. Acta Mycol Sinica 10: 263–265. (in Chinese).
- Wang Y, Moreno G, Rioussset LJ, Manjón JL, Rioussset G, Fourré G, Massimo GD, García Montero LG, Díez J. 1998. *Tuber pseudoexcavatum* sp. nov., a new species from China commercialized in Spain, France and Italy with additional comments on Chinese truffles. Cryptog Mycol 19: 113–120.
- Wang Y, He XY. 2002. *Tuber huidongense* sp. nov. from China. Mycotaxon 83: 191–194.
- Wang YJ, Tan ZM, Murat C, Jeandroz S, Le Tacon F. 2007. Molecular taxonomy of Chinese truffles belonging to the *Tuber rufum* and *Tuber puberulum* groups. Fungal Divers 24: 301–328.
- White TJ, Bruns T, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: MA Innis, DH Gelfand, JJ Sninsky, TJ White, eds. PCR Protocols. Academic Press, San Diego New York Boston. pp. 315–322.
- Xu AS. 1999. Notes on the genus *Tuber* from Tibet. Mycosystema 18: 361–365. (in Chinese).
- Yang ZL. 2000. Type studies on agarics described by N. Patouillard (and his co-authors) from Vietnam. Mycotaxon 75: 431–476.
- Zhang BC, Minter DW. 1988. *Tuber himalayense* sp. nov. with notes on Himalayan truffles. Tran Br Mycol Soc 91: 593–597.
- Zambonelli A, Salomoni S, Pisi A. 1993. Caratterizzazione anatomo-morfologica delle micorrize di *Tuber* spp. su *Quercus pubescens* Willd. Micol Ital 3: 73–90.
- Zambonelli A, Salomoni S, Pisi A. 1995. Caratterizzazione anatomo-morfologica delle micorrize di *Tuber borchii*, *Tuber aestivum*, *Tuber mesentericum*, *Tuber brumale*, *Tuber melanosporum* su *Pinus pinea*. Micol Ital 2: 119–137.
- Zambonelli A, Iotti M, Govi G. 1998. Caratterizzazione anatomo-morfologica delle micorrize in una tartufaia coltivata di *Tuber borchii* Vittad. Micol Ital 27: 23–36.

***Inocybe spuria*, a new species in section *Rimosae* from boreal coniferous forests**

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Abstract – *Inocybe spuria*, a new boreal species in section *Rimosae*, is described. It resembles *I. squamata* but differs in having narrower spores. In Fennoscandia there are documented records of *I. spuria* from Sweden, Norway, and Finland. Sequence comparison in Genbank indicates that it also occurs in boreal to sub-boreal regions of North America. *Inocybe squamata* is known only from nemoral and hemiboreal regions in Fennoscandia.

Key words – *Agaricales*, phylogeny, taxonomy

Introduction

Occasionally a fungus belonging to *Inocybe* section *Rimosae* with scattered appressed scales on the cap has been collected in Fennoscandia. The scaly appearance suggests *Inocybe squamata* J.E.Lange but a micro-morphological investigation reveals that the spores are different. They are distinctly phaseoliform and narrow contrary to collections of *I. squamata* where the spores are broadly ellipsoid and only exceptionally slightly phaseoliform. In macro-morphology the two species are very similar, but the lamellae in the narrow-spored specimens are more distinctly yellow and the fruit-bodies are also in average larger. We also found that the specimens with phaseoliform and narrow spores were collected further north, in the boreal and northernmost part of the hemiboreal regions, than *I. squamata*, which in Fennoscandia has only been found in the nemoral and hemiboreal regions.

In a recent molecular phylogenetic study of section *Rimosae* the two species discussed here were found to form two distinct strongly supported clades (Larsson et al., unpublished). Consecutive molecular investigations confirm the results and indicate that the species also occur in boreal to sub-boreal regions of North America. Since no name could be found in the mycological literature (Kauffman 1924, Stuntz 1947, 1954, Kuyper 1986, Stangl 1986, Bon 1997, Kühner 1988) that fits this species description and the molecular

analyses support the supposition that the distinctly phaseoliform and narrow spored species, reminiscent of *I. squamata*, represents an undescribed species with a northern temperate boreal distribution, it is here described as a new to science.

Material and methods

Micro-morphological characters were observed using a Zeiss Axioscope 2 microscope, equipped with phase contrast. Spores and cystidia were measured in a 3% KOH solution at 400 and 1000 x magnification using microscope photos taken with a Canon G9 digital camera using the software AxioVision (Carl Zeiss AB). Unusually large or small spores were not considered. The collections are deposited in the herbarium at Dept. of Plant and Environmental Sciences, University of Gothenburg (GB) if not otherwise indicated. Herbarium acronyms are those given in Index Herbariorum (Holmgren & Holmgren 1998)

Sequences from the complete ITS region, 1200 base pairs of the 5' end of the nuclear LSU ribosomal DNA were generated. DNA extractions, PCR reactions and sequencing were performed as described in Larsson and Örstadius 2008. The sequences have been submitted to GenBank (AM882780, AM882783, AM882785, AM882788, FJ904132, FJ904136, FJ904138, FJ904139)

Sequences were compared to other fungal sequences in GenBank (www.ncbi.nlm.nih.gov) using BLAST (Altschul et al. 1997). Sequences were aligned using the software MAFFT (Katoh et al. 2002) and adjusted manually using the data editor in PAUP* (Swofford 2003).

Heuristic searches for most parsimonious trees were performed using PAUP*. All transformations were considered unordered and equally weighted. Variable regions with ambiguous alignment were excluded and gaps were treated as missing data. Heuristic searches with 1000 random-addition sequence replicates and TBR branch swapping were performed. Relative robustness of clades was assessed by the bootstrap method using 1000 heuristic search replicates with 100 random taxon addition sequence replicate, TBR swapping.

Results of molecular analyses

The BLAST search in GenBank using the ITS 2 region of our unknown *Inocybe* species gave 100% match with sequences submitted as uncultured *Agaricomycotina*, originating from an ecological study performed in a sub-boreal spruce forest in British Columbia (FJ554451, FJ553958, Hartmann pers. comm.) and one sequence with 99% match submitted as *Inocybe* sp. (EU600893) from Utah with *Picea* and *Abies* as possible hosts. BLAST search using partial LSU gave one sequence with 100% match submitted as *Inocybe squamata* (EU600868) originating from Utah with *Picea*, *Abies*, and *Populus* as possible hosts and one sequence with 99% match submitted as *I. cf. maculata* (AY038321). The latter sequences were included in two phylogenetic studies by Matheny et al. (2002) and Matheny et al. (2009).

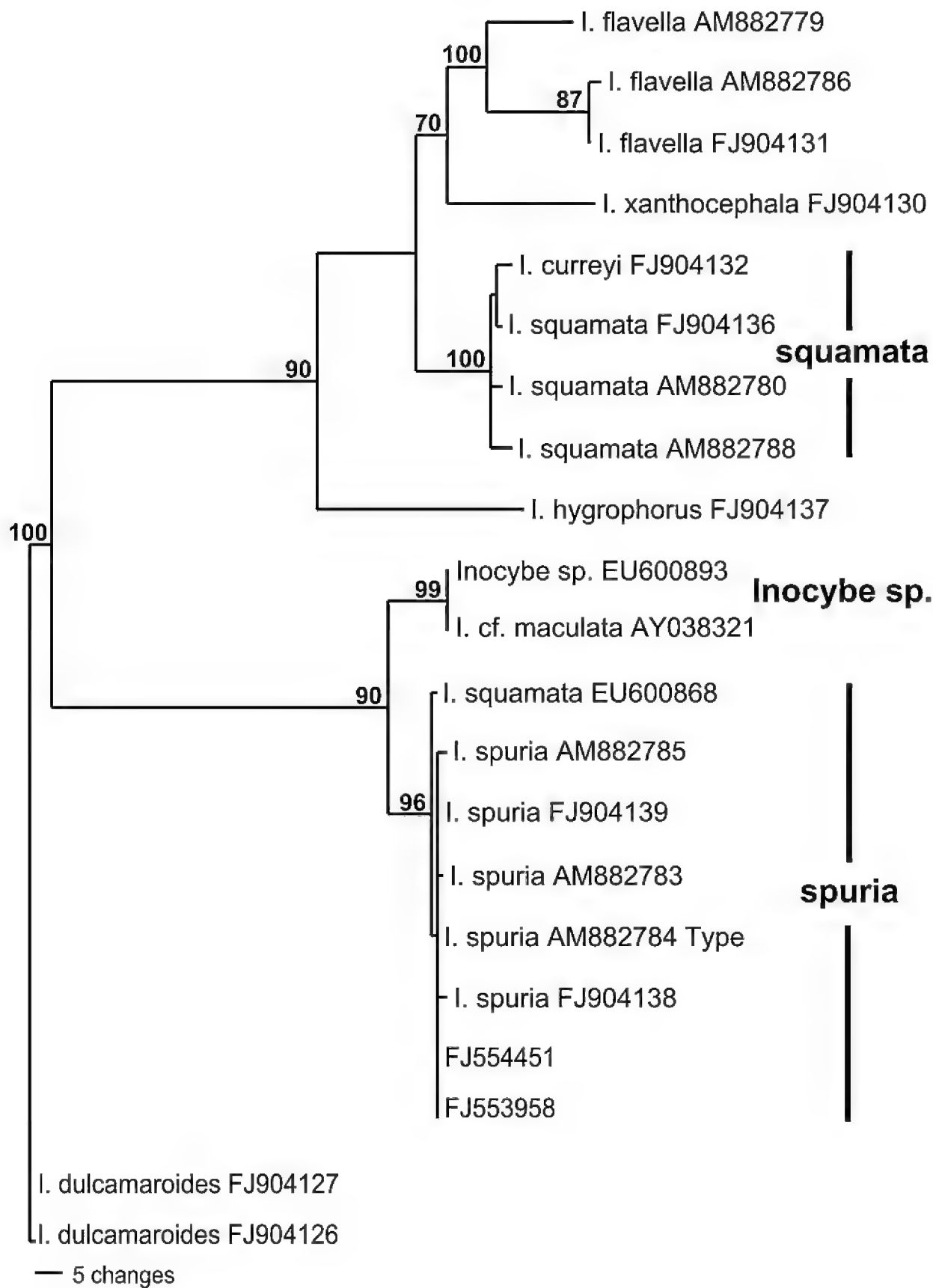


FIG. 1. One of the equally most parsimonious trees obtained from the maximum parsimony analysis presented as a phylogram. Bootstrap values are indicated on branches. Discussed species are marked with a bar. The sequence of the type specimen of *Inocybe spuria* is indicated.

The aligned data set of twenty-one sequences was 2156 characters long. After exclusion of ambiguous regions 1990 characters remained for the analysis of which 1824 were constant, 51 were variable and parsimony uninformative, and 115 were parsimony informative.

Maximum parsimony analysis yielded 305 equally most parsimonious trees (length=202, CI=0.8762, RI=0.9322). FIGURE 1 shows one of the equally most parsimonious trees presented as a phylogram with bootstrap frequencies indicated on branches. Bootstrap analysis recovered *I. squamata* (100%) and *I. spuria* (96%) as strongly supported independent clades. In addition two sequences originating from North America cluster as a sister clade to *I. spuria*, named *Inocybe* sp. in the tree. This clade may represent yet another undescribed species; however we have no known records of this species from Fennoscandia.

Taxonomy

Inocybe spuria Jacobsson & E. Larss., sp. nov.

FIGS. 2–3

MYCOBANK 513381

Pileus 30–90 mm *latus*, *conico-convexus*, *dein applanatus*, *acute vel obtuse umbonatus*, *sericeo-fibrillosus*, *brunneoflavus vel fulvo tinctus*, *juxta marginem flavus interdum*, *centro brunneo squamulosus*. *Lamellae* *anguste adnatae*, *primum pallido-luteae*, *deinde ochraceo-brunneae*, *marginem albido*. *Stipes* *aequalis*, 40–70 × 5–15 mm, *primum albidus*, *tum luteo-brunneus vel ochraceo-fulvus*, *fibrillosus*. *Basidia* 27–36 × 9–13 µm, 4-sporigera. *Sporae* 8.5–11 × 4.5–6 µm (Q 1.6–2.0), *elongato-phaseoliformes*. *Cheilocystidia* 35–46 × 10–22 µm, *clavatae*, *usque ad subcylindricae vel subutriformae*. *In silvis*, *praecipue ad terram calcaream*.

HOLOTYPE: Sweden, Jämtland, Östersund, Lövsbergaparken, 11 Aug. 1992, SJ92-017, in herbarium GB *conservatus est*.

ETYMOLOGY: “false”, similar to *I. squamata*.

PILEUS 30–90 mm, conical-convex, then applanate but mostly with a more or less prominent, blunt to acute umbo (similar to *I. rimosa*), sericeous-fibrillose, not rimose, yellow to warm yellowish brown, at least in centre with appressed dark brown to brownish scales. **LAMELLAE** narrowly adnate, crowded or moderately crowded (L = 50–90), when young pale but later distinctly yellow, then yellowish or olivaceous brown with whitish edge. **STIPE** equal, 40–70 × 5–15 mm, at first whitish but soon discolouring to yellowish brown or brown, longitudinally fibrillose, apex slightly flocculose.

BASIDIA 27–36 × 9–13 µm, 4-spored. **SPORES** 8.5–11 × 4.5–6 µm, (Q = 1.6–2.0), ellipsoid-ovoid-subcylindrical, a majority slightly to distinctly phaseoliform in profile. **CHEILOCYSTIDIA** 35–46 × 10–22 µm, rather variable in shape, a majority clavate, some subcylindrical or with a tendency to become capitate or subutriform. Stem apex with scattered caulocystidia similar to the pleurocystidia.



FIG. 2. *Inocybe spuria* SJ92-017 (Holotype).

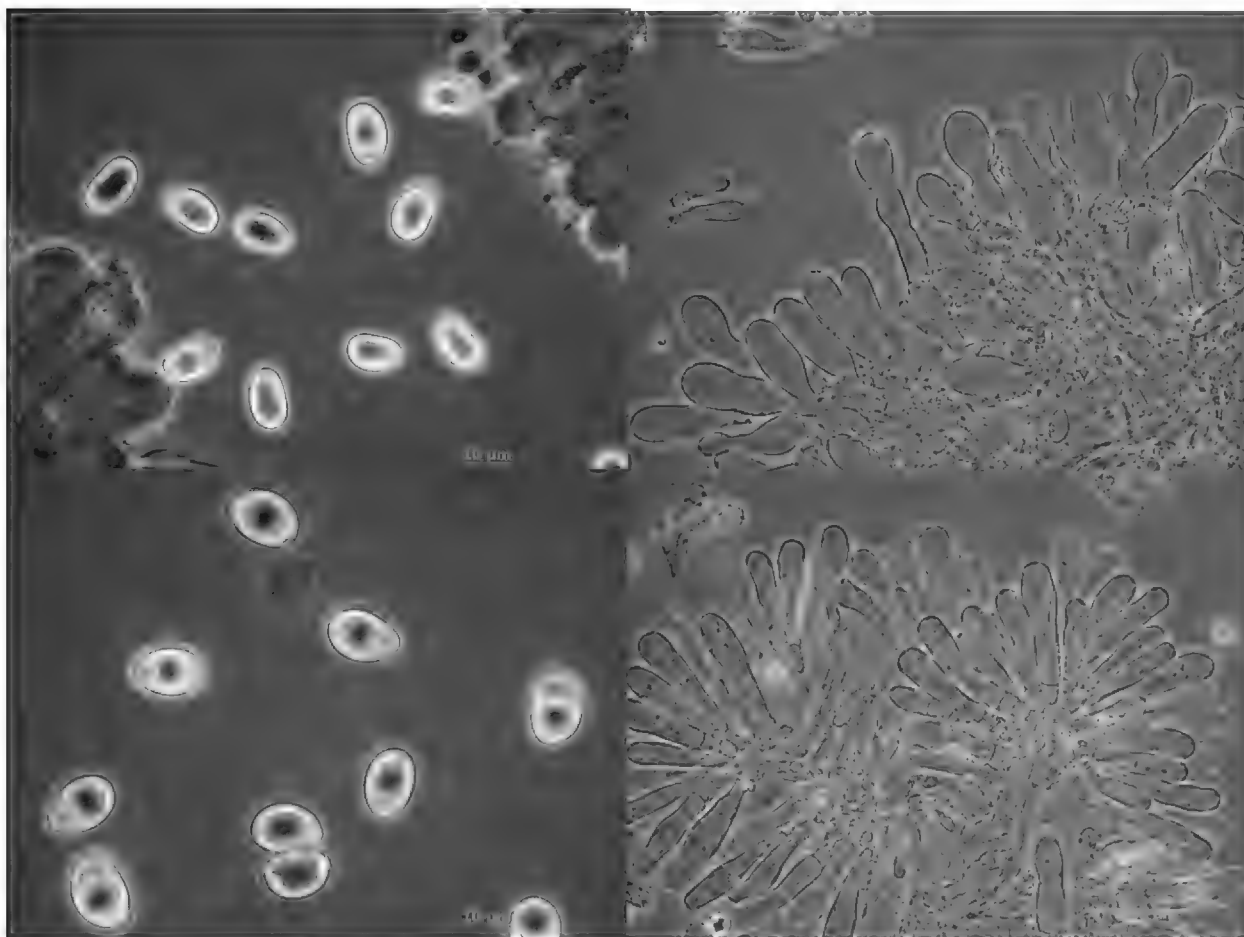
ECOLOGY AND DISTRIBUTION – On nutrient-rich, preferably calcareous soil, often along paths in coniferous or mixed forests, close to *Picea*, *Pinus*, *Populus*, and *Betula*. Distributed in Fennoscandia in boreal areas of Sweden and Norway and one record from the hemiboreal region of Finland. Molecular data also indicate the occurrence of the species in Canada and the USA.

ADDITIONAL SPECIMENS EXAMINED. *Inocybe spuria* – FINLAND: Varsinais-Soumi: Turku, Ilpoinen, 14 July, 1987, J. Vauras 2607(TUR-A). – NORWAY: Oppland; Østre Toten, 5 July 1977, J.Stordal 18318 (O); Oppland; Lunner, 30 July 2004, T.E. Brandrud 102-04 (O). – SWEDEN: Jämtland; Lit, Niklasbodarna, 10 Aug. 1992, SJ 92010 (GB); Medelpad; Tuna, Uvberget, 19 Aug. 1992, S. Muskos 92-013, (GB).

Inocybe squamata – FRANCE: Monbéqui: Tarn et Garonne, 11 Nov. 2003, PAM03111204 (LIP); Lille: Parc Faculte du Pharmacie, 23 May 2005, PAM05052301 (LIP). – SWEDEN: Bohuslän: Torslanda, Röds skalgrusbank, 10 Aug 2008, SJ08-003; Torslanda, Röds skalgrusbank, 28 Aug 2008, SJ08-007. Öland: Gräsgård, Löt, 27 Aug. 1997, TK96-109.

COMMENTS — In macromorphology *I. spuria* is very similar to *I. squamata* and for a long time it was erroneously identified as such in Fennoscandia. We found that the fruitbodies of *I. spuria* are in average larger and more robust. The colours are generally warmer with more reddish and yellow shades present. Distinctly pale yellow lamellae may be a good indication for *I. spuria* but a yellowish or olivaceous flush may be present also in *I. squamata*. All these characters are however rather variable and overlapping making an identification based only on macro-morphological characters uncertain.

Lange (1917) described *I. squamata* from the nemoral region, on the island of Falster in southern Denmark growing on clayey ground with *Populus*. He stated that the spores were broadly ovate-ellipsoid and gave the measures 9.5–10 x 5.5–6.25 µm. The spore shape is also illustrated in his painting of *I. squamata* in Flora Agaricina Danica (Vol 3, p1 115 D, 1938).



FIGS 3–4. Comparison of microcharacters in *Inocybe spuria* and *I. squamata*.

FIG. 3 (top). *I. spuria* (JV2607)—a: Spores (1000×) b: Cheilocystidia (400×). FIG. 4 (bottom). *Inocybe squamata* (SJ08-003) — a: Spores (1000×) b: Cheilocystidia (400×).

The basidiospores constitute the best character to separate *I. spuria* from *I. squamata*. They are distinctly narrower in *I. spuria* (Q 1.6–2.0) and a majority is phaseoliform (FIG. 3a). In *I. squamata* the spores generally are broadly ellipsoid (Q 1.4–1.6) and not or only in certain collections weakly phaseoliform (FIG. 4a). The variation in cheilocystidial morphology is very similar in the two species and therefore not reliable for species identification (FIGS. 3b and 4b).

Inocybe spuria is possibly a mainly boreal species since no narrow-spored specimens are mentioned in the literature from southern parts of the Fennoscandian countries or from Central Europe. All descriptions of *I. squamata* in the literature indicate the spores as (broadly) ellipsoid for *I. squamata* (Kuyper 1986, Stangl 1989, Bon 1997). However, it is of course possible that collections of *I. spuria* exist in various herbaria labeled *I. squamata* without noticing the spore difference.

There are two other species of section *Rimosae* characterized by having scales on the cap centre: *Inocybe mimica* Masee and *I. curreyi* (Berk.) Sacc. Both differ from *I. spuria* and *I. squamata* by having pronounced larger spores. *Inocybe curreyi* was also considered to be an aberrant form of *I. rimosa* by Kuyper (1986), who accordingly synonymized it with that species.

Acknowledgements

We are grateful to Tommy Knutsson, Pierre-Arthur Moreau, Siw Muskos, and Jukka Vauras for sending interesting collections. We also thank the herbaria GB, LIP, O, S, TUR-A for administrating loans and Gro Gulden (Oslo, Norway) and Jukka Vauras (Turku, Finland) for corrections of the manuscript and serving as pre-submission reviewers. This work was financed by the Swedish species initiative, Artdatabanken, SLU, Uppsala (grant dha146/05 to EL), and Kapten Carl Stenholm's foundation.

Literature cited

- Altschul SF, Madden TL, Schaffer AA, Zhang J, Zhang Z, Miller W, Lipman DJ. 1997. Gapped BLAST and PSI-BLAST: a new generation of protein database search programs. *Nucleic Acids Research* 25: 3389–3402.
- Bon M. 1997. Clé monographique du genre *Inocybe* (Fr.) Fr. *Documents Mycologique* 27(105): 1–51.
- Holmgren PK, Holmgren NH. 1998. Index Herbariorum. A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium, <http://sweetgum.nybg.org/ih/>.
- Katoh K, Misawa K, Miyata T. 2002. MAFFT: a novel method for rapid multiple sequence alignment based on Fourier transform. *Nucleic Acids Research* 30:3059–3066.
- Kauffman CH. 1924. *Inocybe*. *North American Flora* 10: 227–261.
- Kuyper TW. 1986. A revision of the genus *Inocybe* in Europe. I. Subgenus *Inosperma* and the smooth-spored species of subgenus *Inocybe*. *Persoonia Suppl.* 3: 1–247(43–68).
- Kühner R. 1988. Diagnoses de quelques nouveaux *Inocybes* récoltés en zone alpine de la Vanoise (Alpes françaises). *Documents Mycologiques* 19(74): 1–27.
- Lange J. 1917. Studies in the Agaricales of Denmark, Part III. The genus *Inocybe*. *Dansk Botanisk Arkiv* 7: 23–48.
- Lange J. 1938. *Flora Agaricina Danica*, 3. Copenhagen.
- Larsson E, Örstadius L. 2008. Fourteen coprophilous species of *Psathyrella* identified in the Nordic countries using morphology and nuclear rDNA sequence data. *Mycological Research* 112: 1165–1185.
- Matheny PB, Liu YJ, Ammirati JF, Hall BD. 2002. Using RPB1 sequences to improve phylogenetic inference among mushrooms (*Inocybe*, *Agaricales*). *American Journal of Botany* 89: 688–698.
- Matheny PB, Aime MC, Bougher NL, Buyck B, Desjardin DE, Horak E, Kropp BR, Lodge DJ, Soyong K, Trappe JM, Hibbett DS. 2009. Out of the Palaeotropics? Historical biogeography and diversification of the cosmopolitan ectomycorrhizal mushroom family *Inocybaceae*. *Journal of Biogeography* 36: 577–592.
- Stangl J. 1989. Die Gattung *Inocybe* in Bayern. *Hoppea* 46: 5–388.
- Stuntz D.E. 1947. Studies on the genus *Inocybe*. I. New and noteworthy species from Washington. *Mycologia* 39: 21–55.
- Stuntz D.E. 1954. Studies on the genus *Inocybe*. II. New and noteworthy species from Michigan. *Papers of the Michigan Academy of Sciences, Arts, and Letters*. 39: 53–84.
- Swofford DL. 2003. PAUP*. *Phylogenetic Analysis Using Parsimony (* and Other Methods)*. Version 4. Sinauer Associates, Sunderland, MA.

New species and new reports of *Diorygma* (lichenized Ascomycotina, Graphidaceae) from India

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Abstract — Four species in the lichen genus *Diorygma* including the two new species *D. longilirellatum*, *D. saxicola* and two new combinations *Diorygma rufosporum* and *D. subalbatum* are recognized in India.

Keywords — lichenized fungi, ascomycetes, taxonomy

Introduction

The lichen genus *Diorygma* Eschw., with thirty three species throughout the world (Kalb et al. 2004, Archer 2006, 2007, Archer & Elix 2008, Cáceres 2007, Sharma & Makhija 2009), is widely distributed in tropical to subtropical regions.

In a recent account of the genus *Diorygma* (Kalb et al. 2004), four species, namely *D. junghuhnii* (Mont. & Bosch) Kalb et al., *D. megasporum* Kalb et al., *D. pruinsum*, and *D. tuberculosum* (Stirt.) Kalb et al., were reported from India. In addition, *D. hieroglyphicum* was reported from the Andaman Islands. Four additional new species, namely *Diorygma dealbatum* B.O. Sharma & Makhija, *D. inaequale* B.O. Sharma & Makhija, *D. manipurens* B.O. Sharma & Makhija, and *D. verrucirimosum* B.O. Sharma & Makhija, with divergent exciples and muriform, hyaline ascospores, and with norstictic and salazinic acids, have been recorded (Sharma & Makhija 2009).

Further studies in the family *Graphidaceae* from India have resulted in the recognition of four additional species, including two new species and two new combinations, which are described below.

Materials and methods

In the present work chemical data was obtained by the standard methods of TLC (Culberson & Kristinsson 1970, White & James 1985) using solvent systems benzene-dioxane-acetic acid (180:45:5), hexane-ethyl ether-formic acid

(130:80:20) and toluene-ethyl acetate-formic acid (139:83:8). The specimens have been deposited in the Ajrekar Mycological Herbarium (AMH).

Key to the species

- 1a. Ascospores 1/ascus or rarely 2/ascus2
- 1b. Ascospores more than 1/ascus 6
- 2a. Protocetraric acid present (ascocarps 1–3 mm long; disc grayish, pruinose; exciple non-carbonized or carbonization sometimes restricted to the basal corners; asci 1-spored; ascospores muriform, 147–160 × 33.6–42 µm; protocetraric acid present)..... *D. pruinoseum*
- 2b. Protocetraric acid absent 3
- 3a. Ascospores more than 200 µm long (ascocarps 1–3 mm long; disc yellowish to brownish, pruinose; asci 1-spored; ascospores muriform, (135–) 168–205 × 54–96 µm, with a 5–7.5 µm, thick gelatinous sheath; constictic and stictic acids present).....*D. rufosporum*
- 3b. Ascospores less than 200 µm long4
- 4a. Norstictic acid absent (Ascocarps whitish, 0.4–3 mm long; disc whitish, 0.2–0.4 mm broad; asci 1-spored; ascospores muriform, 126–130 × 37–42 µm, with a 5–15 µm thick sheath; constictic, stictic, acids present) *D. hieroglyphicum*
- 4b. Norstictic acid present 5
- 5a. Thallus greenish grey with red tinge; ascocarps long flexuous, branched, up to 9 mm long, immersed; disc pale brown; ascospores muriform, 105–113 × 34–42 µm; norstictic acid present *D. longilirellum*
- 5b. Thallus creamy white, grayish; ascocarps 0.4–4 mm long, round to irregular; disc 0.2–0.3 mm broad, pale brown; asci 1(–2)-spored; ascospores 84–134.4 × 29.4–42 µm, with a 2.3–5 µm sheath; constictic acid (trace), norstictic, and stictic acid (major) present *D. junghuhnii*
- 6a. Thallus saxicolous; ascocarps crowded, immersed to slightly emergent; disc narrow to slightly broad, 0.2–0.3 mm broad in section; exciple indistinctly striate; asci 1–6-spored; ascospores 143–172 × 29.4–33.6 µm; constictic, nonstictic (trace) and stictic acids present*D. saxicola*
- 6b. Thallus corticolous, ashy white; ascocarps white, straight to curved, branched, 0.5–2.5 mm long, immersed; disc 0.3–0.6 mm broad; exciple convergent to divergent, indistinctly striate; asci 1–8-spored; ascospores 75–145 × 24–33.6 µm; norstictic, stictic, acids present. *D. subalbatum*

Diorygma hieroglyphicum (Pers.) Staiger & Kalb

Symb. Bot. Upsal. 34(1): 151 (2004).

FIGURE 1

= *Opegrapha hieroglyphica* Pers., Ann. Wetterauischen Ges. Gesamte Narurk. 2: 16 (1811).

= *Graphis particeps* Nyl., Bull. Soc. Linn. Normandie Sér. 2, 7:177 (1874).

= *Graphina particeps* (Nyl.) Müll. Arg., Flora 65: 386, 1882.

TYPE of *Graphis particeps*: Andaman Islands, in coll. Hook. Thoms. 2264 (H-NYL holotype)

Thallus greenish with whitish tinge, smooth, often with fine cracks, 120–140 µm thick; surface continuous; delimited by thin blackish brown hypothallus; pseudocortex not visible; medulla and algal layer not differentiated, studded with crystals. Ascocarps off white to concolourous with the thallus, immersed to semi-emergent, short, flexuous, branched, narrow, curved, irregular, 1–4 mm long, ends acute to obtuse. Disc broad, brown, 0.2–0.4 broad, pruinose. Exciple non-carbonized, poorly developed, yellowish brown laterally and basally not striate. Epithecium distinctly developed, 12–15 µm high, brown consisting of intermingled anastomosing, hyaline paraphysis tips. Hymenium hyaline, 90–110 µm tall, not inspersed. Asci 1-spored. Ascospores muriform, hyaline, peripheral and central spore locules of equal size, 80–131 × 42–52 µm, with a 5–15 µm thick sheath, I+ violet.

CHEMISTRY—Stictic, constictic and norstictic acids present.

ADDITIONAL SPECIMENS EXAMINED—North Andaman, Diglipur Range, Sitapur, moist deciduous forest, P.G. Patwardhan & M.B. Nagarkar 86.229, South Andaman, Port Mount, M.B. Nagarkar & P.G. Patwardhan, 85.9; Maharashtra State, Pune district, Khandala, P.G. Patwardhan, 70.1a; Sindhudurg district, on the way to Vaibhavwadi to Phonda, B.C. Behera & V.A. Mantri, 00.326:AMH.

REMARKS—*Diorygma hieroglyphicum* is a pantropical species that has been reported from Africa, the Philippines, New Caledonia, Papua New Guinea, and the Andaman Islands (Kalb et al. 2004) and from Australia (Archer 2006). Additional specimens are here reported from India where it occurs in the semi-evergreen forest of Maharashtra.

Diorygma junghuhnii (Mont. & Bosch) Kalb, Staiger & Elix

Symb. Bot. Upsal. 34(1): 157 (2004).

FIGURE 2

= *Ustalia junghuhnii* Mont. & Bosch., Plantae Junghuhnianae Fasc. IV, Lugduni-Batavorum: 477 (1855).

Thallus creamy white, grayish, pale gray, 80–90 µm thick; rough, uneven, cracked, often along the lirellae; delimited by black hypothallus; pseudocortex not visible; medulla not distinct. Ascocarps yellowish to whitish in colour, numerous, round to long, broad, 0.4–4 mm long, 0.2–0.4 mm broad, more or less flexuous, branched, immersed to slightly raised. Disc brownish grey covered by yellowish cream pruina, 0.2–0.3 mm broad. Exciple divergent, non-carbonized, orange yellow at the base. Epithecium distinct, yellowish brown. Hymenium 63–125 µm tall, not inspersed, I+ blue. Asci 1–2-spored. Ascospores hyaline, muriform, 84–134 × 29–42 µm, with a 2.5–5 µm thick sheath, peripheral and central spore locules of equal size, I+ violet.

CHEMISTRY—Constictic (trace), norstictic acids present.

ADDITIONAL SPECIMENS EXAMINED—Assam, Gauhati to Shillong road, 10 km from Gauhati, near Buratti, *P.G. Patwardhan & M.B. Nagarkar*, 77.684; Meghalaya, 20 km near Shillong on Gauhati to Shillong road, above Nowpong near Barapani, *P.G. Patwardhan & M.B. Nagarkar*, 77.711; Shillong, Moflong, *M.B. Nagarkar*, 78.464; Kerala, Near Chinnar, 60 km from Munnar, Munnar-Udumalpet, *P.G. Patwardhan & M.B. Nagarkar*, 85.1734, 85.1735, 85.1736; Tamil Nadu, Kalghatgi to Yellapatii, *M.B. Nagarkar & A.V. Prabhu*, 77.12; Marayoor, Anamalai hills, *P.G. Patwardhan & M.B. Nagarkar*, 76.439; Anamalai hills, Marayoor, *C.R. Kulkarni*, 76.460:AMH

REMARKS—*Diorygma junghuhnii* is a widely distributed tropical species that has been reported from Africa, South America, the Philippines, and Australia (Kalb et al. 2004); in India it was collected from the sacred forest in Moflong of Meghalaya at an altitude of 1300 m and in the evergreen forests of Kerala and Tamil Nadu.

***Diorygma longilirellum* B.O. Sharma & Makhija, sp. nov.**

FIGURE 3

MYCOBANK MB 513336

Similis *Diorygma erythrellum* sed *ascis monosporiis differt*.

ETYMOLOGY: From the Latin *longus*, long, and *lirellatus*, lirelline; a reference to the long lirelline ascocarps.

Holotypus—India, West Bengal, 3 km from Sikkim diversion on Gauhati Road, 23.10.1977, *P.G. Patwardhan & M.B. Nagarkar*, 77.655: AMH.

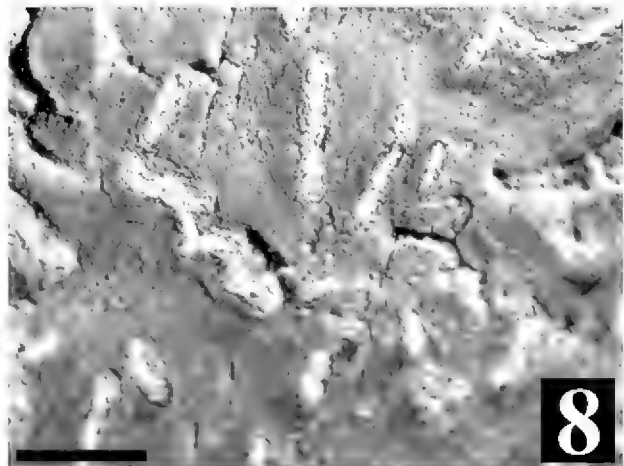
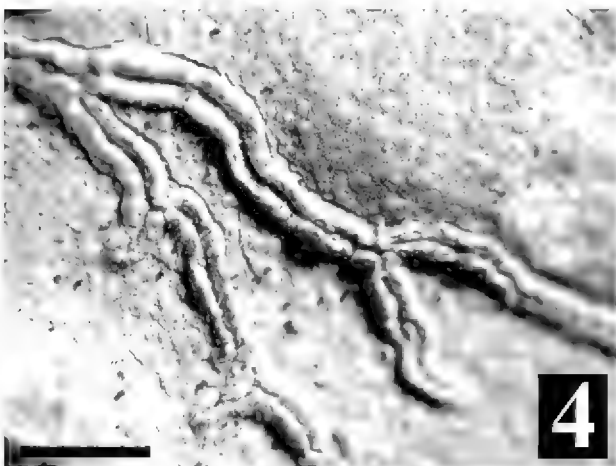
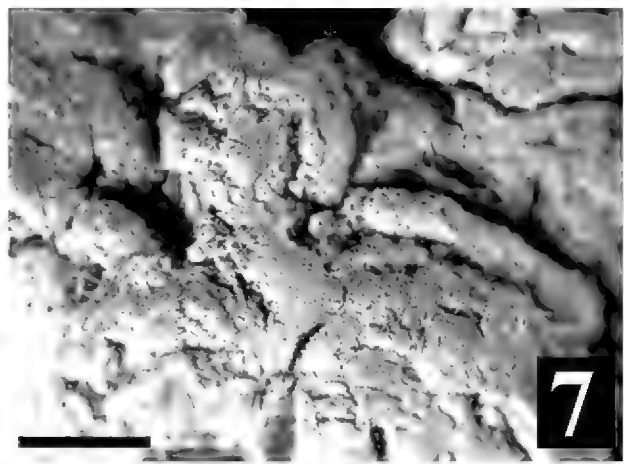
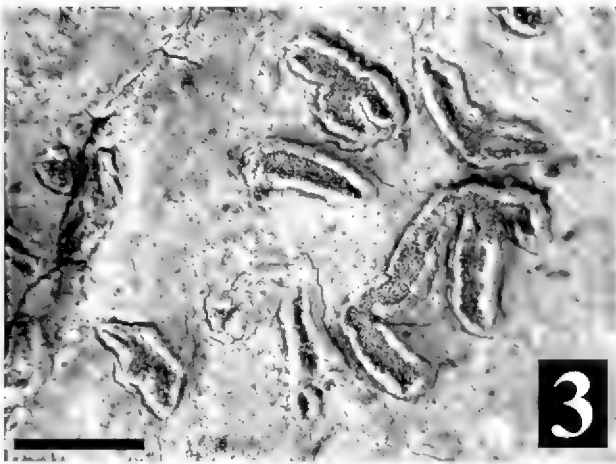
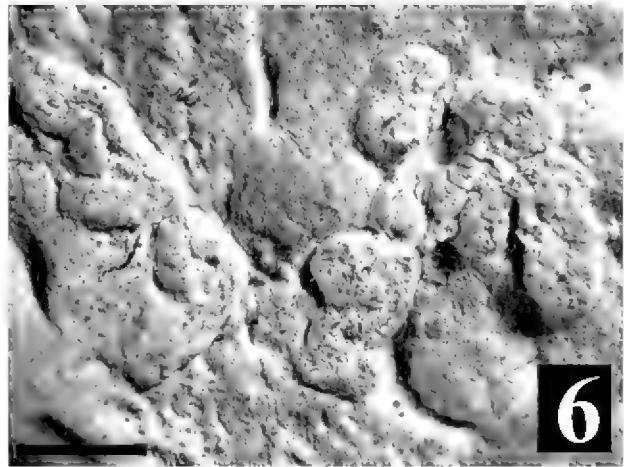
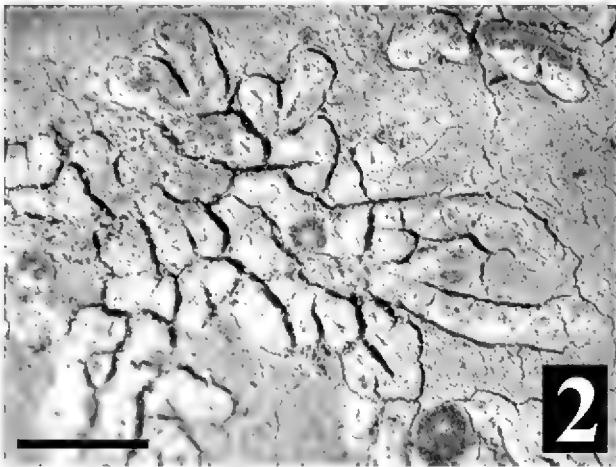
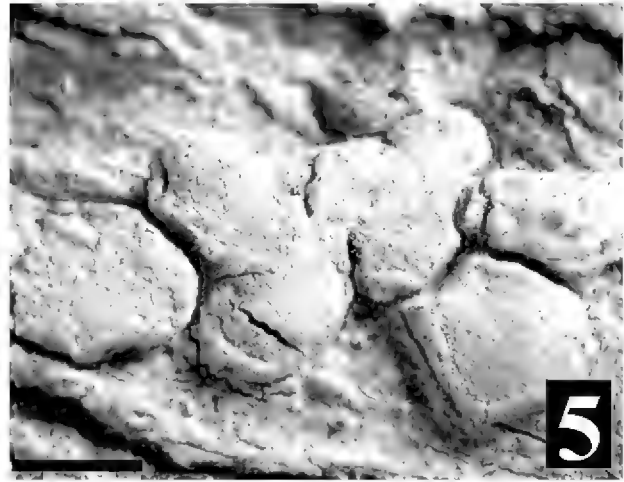
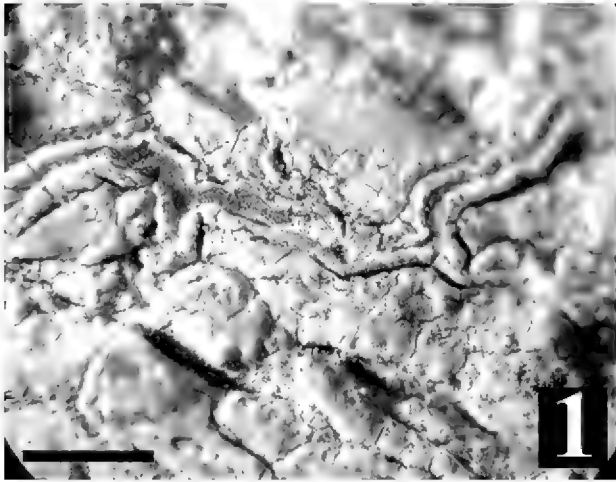
Thallus greenish grey with red tinge, red granular particles seen on the surface of the thallus, 60–70 µm thick; surface more or less smooth, uneven or partly with small warts, delimited by blackish brown hypothallus, notched at the ends; pseudocortex not seen; medulla compact, well developed, not separated from the algal layer, often with many crystals. Ascocarps long flexuous, branched, curved, up to 9 mm long, immersed to more or less raised above the surface of the thallus. Disc slightly open, pale brown, covered by pruina. Exciple convergent to divergent, non-carbonized, poorly developed. Epithecium distinctly developed 20–25 µm high consisting of brownish, paraphyses tips. Hymenium 63–100 µm tall, not interspersed, I+ blue. Asci 1-spored. Ascospores hyaline, muriform, peripheral and central spore locules of equal size, 105–113 × 33–42 µm, I+ violet.

CHEMISTRY—Norstictic acid present.

REMARKS—*Diorygma longilirellum* is characterized by the long lirellae, asci with a single ascospores, and norstictic acid in the thallus.

Many species of this genus contain norstictic acid but the new species, *Diorygma longilirellum*, differs from these species as follows: *D. circumfusum* has transversely septate ascospores, *D. erythrellum* (Mont. & Bosch) Kalb et al.

FIGURES 1–5 (right) Habit. 1. *D. hieroglyphicum*. 2. *D. junghuhnii*. 3. *D. junghuhni* (with broad, dark disc). 4. *D. longilirellum* (Holotype). 5. *D. pruinsum*. 6. *D. rufosporum*. 7. *D. saxicola* (Holotype). 8. *D. subalbatum* Bar = 1 mm



has 8-spored asci, *D. junghuhnii* has con-norstictic acid, *D. macgregorii* (Vain.) Kalb et al. has larger ascospores and a different chemistry, *D. pachygraphum* (Nyl.) Kalb et al. and *D. soozanum* (Zahlbr.) M. Nakan. & Kashiw. have larger ascospores of 170–250 µm and 110–145 µm long respectively, with peripheral cells distinctly smaller than the central ones, and *D. tinctorium* Eschw. and *D. tuberculosum* also have peripheral cells distinctly smaller than the central ones.

***Diorygma pruinsum* (Eschw.) Kalb, Staiger & Elix**

Symb. Bot. Ups. 34(1): 166 (2004).

FIGURE 4

= *Leiogamma pruinsum* Eschw., In Martius, Icones selectae plantarum cryptogamicarum. Fasc. I: 12 tab. 7, Fig. 3 (1828).

Thallus whitish green, thin, easily flaking off from the substratum, 70–100 µm thick; surface smooth, not farinose, slightly cracked; pseudocortex not seen; medulla filled with crystals. Ascocarps concolorous with the thallus, circular, oval, short curved, 1–3 mm long, ends round, simple. Disc grayish, broad covered by white pruina, 0.5–1 mm broad. Exciple divergent, non-carbonized to carbonization sometimes restricted to the basal corners. Epithecium distinctly developed, brown, consisting of brownish reticulately branched paraphysis tips. Hymenium hyaline, 121–150 µm tall, not inspersed, I+ blue. Asci 1-spored. Ascospores hyaline, muriform, peripheral and central spore locules of equal size, 147–160 × 34–42 µm, I+ violet.

CHEMISTRY—Protocetraric acid.

ADDITIONAL SPECIMENS EXAMINED—Andaman Islands, South Andaman, Nilambur, Forest Guest House, Baratang, M.B. Nagarkar & P.G. Patwardhan, 85.313, 85.335, 85.343, 85.373, 85.425, 85.429, 86.146; Port Mount, M.B. Nagarkar & P.G. Patwardhan, 85.11, 85.25, 85.30, 85.31, 85.476, 85.499; Assam, Maniknagar, P.G. Patwardhan & M.B. Nagarkar, 77.1196, 77.1215; Nigwal-Bibra Road, M.B. Nagarkar, 78.309; Kerala, Kumly Kerala Road, C.R. Kulkarni & P.D. Badhe, 73.2257; Tamil Nadu, Wynad forest, P.D. Badhe & C.R. Kulkarni, 73.2308: AMH

REMARKS—*Diorygma pruinsum* is a pantropical species found in Africa, South America, Indonesia, Papua New Guinea, New Caledonia, and Australia (Kalb et al. 2004). In addition, a single specimen was reported from Assam, collected in 1879. Further specimens from India are reported here together with specimens from the Andaman Islands. The species is characterized by a whitish green thallus, a densely pruinose disc, and the presence of protocetraric acid. In India the species is found in the Andaman Islands, Assam, Kerala and Tamil Nadu.

***Diorygma rufosporum* (Patw. & C. R. Kulk.) B.O. Sharma & Makhija, comb. nov.**

MYCOBANK MB 513338

FIGURE 5

= *Phaeographina rufospora* Patw. & C.R. Kulk., Ind. J. Bot. 2(2): 138 (1979).

Holotypus—India, Karnataka, South Canara, Shimoga Dist., Kalkoppa forest, 15.12.1974, C.R. Kulkarni, 74.2914:AMH (!).

Thallus grayish white, powdery, smooth, finely cracked, hypothallus white. Ascocarps concolorous with the thallus, 1–3 mm long, emergent, branched. Disc yellowish to brownish, flat, wide, pruinose. Exciple divergent, non-carbonized. Epithecium distinctly developed, brown, consisting of brownish reticulately branched paraphyses tips. Hymenium hyaline, 125–200 µm tall, not interspersed, I+ blue. Asci 1-spored. Ascospores hyaline, muriform, peripheral and central spore locules of equal size, (135–) 168–205 × 54–96 µm with 5–7.5 µm thick sheath, I+ violet.

CHEMISTRY—Constictic (major) and stictic (major) acids present.

ADDITIONAL SPECIMENS EXAMINED—Maharashtra State, Amboli, Amboli to Sawantwadi Road, M.B. Nagarkar, 74.2355; Karnataka State, North Canara, Khanapur to Londha road, Gangavati, P.G. Patwardhan, 74.2404, 74.2405, 74.2420, 74.2421; Londha, 74.2528, 74.2544, 74.2545, 74.2585, 74.2588; South Canara, Kalkoppa forest, 74.2913, 74.2926: AMH.

REMARKS—*Diorygma rufosporum* was earlier described by Patwardhan & Kulkarni (1979) as *Phaeographina rufospora* from the western Ghats of India. The species is found in semi-evergreen forests.

The species resembles *Phaeographina phlyctidiformis* Müll. Arg. (known from Manipur) with respect to the apothecia and ascospores but differs in chemistry. *P. phlyctidiformis* contains norstictic acid.

***Diorygma saxicola* B.O. Sharma & Makhija, sp. nov.**

FIGURE 6

MYCOBANK MB 513337

Similis *Diorygma megasporum* sed *habitus saxicola* et *excipulo divergentus* differt.

ETYMOLOGY—From the Latin, *saxum*, rock, and the invariable suffix *-cola*, dweller, a reference to the species habitat on rock.

Holotypus: India, Meghalaya, Wiloe, 30.10.1977, P.G. Patwardhan & M.B. Nagarkar, 77.1095:AMH

Thallus saxicolous, greenish to pale gray, rough, uneven, cracked, warty; pseudocortex indistinct, very thin; algal layer 40–50 µm thick; medulla compact, studded with crystals. Ascocarps concolorous, numerous, curved, short, more or less flexuous, round to elongate, simple to branched, very closely arranged, immersed to slightly emergent. Disc narrow to broad, 0.2–0.3 mm broad. Exciple divergent, non-carbonized, poorly developed, yellowish brown laterally and basally, 2–3 indistinct striate at the apical region. Epithecium indistinct, brown, 7–10 µm thick. Hymenium hyaline, 126–210 µm tall, I+ blue violet laterally, not interspersed. Asci 1–6-spored. Ascospores hyaline, muriform, peripheral and central spore locules of equal size, 143–172 × 29–34 µm, I+ violet.

CHEMISTRY—Stictic, constictic and norstictic (trace) acids present.

REMARKS—The new species closely resembles *Diorygma megasporum* but *D. megasporum* has a convergent exciple and is corticolous. In contrast, *D. saxicola* has a divergent exciple and is saxicolous. So far no other species in the genus are known to be saxicolous except one collection mentioned in Kalb et al. (2004, p. 141). The species was collected in the evergreen forests of Meghalaya at a higher elevation of ca 1400 m.

Diorygma subalbatum (Patw. & Makhija) B.O. Sharma & Makhija, **comb. nov.**

MYCOBANK MB 513349

FIGURE 7

= *Helminthocarpon subalbatum* Patw. & Makhija, Biovigyanam 7: 128 (1981)

Holotypus—India, Karnataka, Hebri, on Agumbe to Udipi road, in rain forest, elev. Approx. 200 m., A.V. Prabhu & M.B. Nagarkar, 77.500 (AMH) (!)

Thallus ashy white, smooth, delimited by black hypothallus. Ascocarps whitish, numerous, straight to curved to flexuous, branched, 0.5–2.5 mm long, 0.3–0.6 mm broad, obtuse at the end, immersed or flushed with the thallus. Disc narrow to broad, white pruinose. Exciple convergent to divergent, non-carbonized, indistinctly striate. Epithecium indistinct, pale brown. Hymenium hyaline, 150–210 µm tall, I+ blue violet, not interspersed. Asci 1–8-spored. Ascospores hyaline, muriform, peripheral and central spore locules of equal size, 75–145 × 24–34 µm, I+ violet.

CHEMISTRY—Norstictic, and stictic acids present.

ADDITIONAL SPECIMENS EXAMINED—Karnataka, Hebri, P.G. Patwardhan & M.B. Nagarkar, 77.503, 77.546:AMH

REMARKS—*Diorygma subalbatum* was described by Patwardhan & Makhija (1981) as *Helminthocarpon subalbatum* from the western Ghats of south India. This species is found in rain forest at lower elevation of ca. 200 m.

Acknowledgements

We would like to thank Dr. A.W. Archer and Dr. Andre Aptroot for the valuable suggestions. We are grateful to the Department of Science and Technology (DST), Government of India, New Delhi for the financial support. We also thank Miss Pradnya Khadilkar for preparing illustrations.

Literature cited

- Archer AW. 2006. The lichen family *Graphidaceae* in Australia. *Biblioth. Lichenol.* 94: 1–191.
- Archer AW. 2007. Key and checklist for the lichen family *Graphidaceae* (lichenized *Ascomycota*) in the Solomon Islands. *Systematics & Biodiversity* 5(1): 9–22.
- Archer AW, Elix JA. 2008. Three new species in the Australian *Graphidaceae* (lichenized *Ascomycota*). *Australasian Lichenology* 63: 26–29.
- Cáceres MES. 2007. Corticolous crustose and microfoliose lichens of northeastern Brazil. *Libri Botanici* 22: 1–168.
- Culberson CF, Kristinsson H. 1970. A standardized method for the identification of lichen products. *J. Chromatogr.* 46: 85–93.

- Kalb K, Staiger B, Elix JA. 2004. A monograph of the lichen genus *Diorygma* – a first attempt. Symb. Bot. Ups. 34: 133–181.
- Patwardhan PG, Kulkarni CR. 1979. The lichen genus *Phaeographina* (Family *Graphidaceae*) in the western ghats, southwestern India. Biovigyanam 2(2): 132–143.
- Patwardhan PG, Makhija UV. 1981. Some new species of lichens from the Western Ghats, South western India. Biovigyanam 7: 121–129.
- Sharma B, Makhija U. 2009. Four new species in the lichen genus *Diorygma*. Mycotaxon 107: 87–94.
- White FJ, James PW. 1985. A new guide to microchemical techniques for the identification of lichen substances. Bull. Br. Lichen Soc. 57(Suppl.): 1–41.

***Exidia nigricans*:
a new and legitimate name for *Exidia plana***

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Abstract — The new combination *Exidia nigricans* is proposed to replace the illegitimate *Exidia plana*.

Keywords — *Basidiomycota*, *Basidiomycetes*, *Auriculariales*

Molecular sequencing (Weiss & Oberwinkler, 2001) has confirmed the existence of two macroscopically distinct (but microscopically similar) European species in the *Exidia glandulosa* (Bull.) Fr. complex, a group of blackish, gelatinous heterobasidiomycetes (*Auriculariales*) saprotrophic on deciduous trees. The turbinate species, common in the British Isles on oak (*Quercus* spp) and hazel (*Corylus avellana*), is *Exidia glandulosa* sensu stricto (syn. *E. truncata* Fr.), as noted by Donk (1966). The effused, coalescing species, not uncommon on other deciduous trees, was referred to *Tremella plana* “Wigg. per Schleich.” by Donk (1966), as the earliest valid name published after 1821, the then starting point date for this group of fungi under the Code of Botanical Nomenclature.

With the subsequent change in starting point date to 1753, however, *Tremella nigricans* With. (acknowledged by Donk 1966 as the earliest published name for the effused species) became the earliest valid name for this taxon. (Note that *Tremella nigricans* Bull., which provided the epithet for the sanctioned name *Tubercularia nigricans* Link : Fr., is not itself sanctioned and hence is an illegitimate, later homonym of *Tremella nigricans* With.) As a further consequence of the change in starting point date, *Tremella plana* F.H. Wigg. (Wiggers, 1780) became an illegitimate homonym of *T. plana* With. (Withering, 1776), itself a nomen dubium until typified. Consequently, the binomial *Exidia plana* is to be attributed to Donk alone (McNeill et al., 2006: Art. 58.1) dating from 1966, and itself is superfluous and hence illegitimate (McNeill et al., 2006: Art. 52.1) because of the inclusion of several earlier available epithets. Articles in the Code are retroactive unless specifically limited.

Tremella nigricans With. is, fortunately, a more plausible name than the illegitimate *T. plana* F.H. Wigg. since the latter was described by Wiggers (1780) as ‘initio viridis dein aterrimus’ (green at first becoming black), suggesting a gelatinous cyanobacterium (*Nostoc* sp.) rather than a fungus. The description of *T. nigricans* (Withering, 1776) is not only more correct in colour terms, but includes a reference to a pre-Linnean description by Dillenius (1741), who noted the presence of hyphal pegs (a macroscopically visible feature of the species not mentioned by Wiggers). Both Dillenius and Withering called *T. nigricans* ‘witches-butter’, a vernacular name long associated with *Exidia glandulosa* s.l.

The new combination *Exidia nigricans* is therefore proposed as both an earlier and a more appropriate name for the species hitherto known as *Exidia plana*.

***Exidia nigricans* (With.) P. Roberts comb. nov.**

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≡ *Tremella nigricans* With., Bot. Arrang. Veg. Great-Britain 2: 732 (1776)

[non *T. nigricans* Bull. (1790), nec Poir. (1808), nec (Fr.) Sacc. (1888)]

= *Tremella plana* F.H. Wigg., Prim. Fl. Holsat.: 95 (1780) [nom. illegit.,

non *T. plana* With. (1776)]

≡ *Exidia plana* Donk [ut “(Wigg.) Donk”], Persoonia 4: 228 (1966) [nom. illegit.]

Acknowledgments

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References

- Dillenius JJ. 1741. *Historia muscorum*. Oxford.
- Donk MA. 1966. Check list of European hymenomycetous heterobasidia. *Persoonia* 4: 145–335.
- McNeill J, Barrie FF, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema J, Turland NJ. 2006. *International Code of Botanical Nomenclature (Vienna Code)*. Adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. *Regnum Vegetabile* 146.
- Weiss M, Oberwinkler F. 2001. Phylogenetic relationships in *Auriculariales* and related groups – hypotheses derived from nuclear ribosomal DNA sequences. *Mycol. Res.* 105: 403–415.
- Wiggers FH. 1780. *Primitiae florae Holsaticae*. Kiel.
- Withering W. 1776. *A botanical arrangement of all the vegetables naturally growing in Great-Britain*, Vol. II. Birmingham.

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Phaeocandelabrum*, a new genus of anamorphic fungi to accommodate *Sopagraha elegans* and two new species, *Ph. callisporum* and *Ph. joseiturriagae

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Abstract — *Phaeocandelabrum* anam. gen. nov. is established to accommodate *Sopagraha elegans*, *Ph. callisporum* sp. nov. found on dead leaves of *Cupania paniculata* (Sapindaceae) and on the decaying leaf of an unidentified dicotyledonous plant in Brazil,

and *Ph. joseiturriagae* found on decaying leaves of unidentified dicotyledonous plants in Brazil and Venezuela. *Phaeocandelabrum callisporum* is distinguished by complex, brown conidia composed of 2 globose, brown to dark central cells; 7–10 secondary hemispherical cells and, on each secondary cell, 3–4 hemispherical satellite cells, each with 5 simple, incurved branches. *Phaeocandelabrum joseiturriagae* is characterized by more less broadly Y-shaped to irregular brown conidia, each with a basal cell and two branches composed of 5–7 subglobose to globose cells, with 8–14 secondary cells each subtending 3–5 dichotomous or trichotomous minute tubercles. All three species are described and illustrated.

Key words — tropical rainforest, systematics, conidial fungi

Introduction

Sopagraha elegans (Castañeda 1985) was described from a sample collected on decaying leaves of *Cedrela mexicana* in Cuba. Another collection has been made from the Centro de Investigaciones Costera “La Mancha”, Veracruz, Mexico. Two additional taxa congeneric with *S. elegans* were subsequently discovered during study of collections from Venezuela and Brazil. *Phaeocandelabrum* is described to accommodate the three taxa, which are fully described and illustrated herein

Materials and methods

Samples of submerged plant material were collected during expeditions in 2000 through the forest near “Colonia Tovar”, Aragua State, Venezuela and in 2002 and 2006 through the “Morro do Corcovado” rainforest, Senhor do Bonfim, and Chapada Diamantina regions of Brazil. Individual collections were placed in paper bags and taken to the laboratory, then incubated in Petri dishes at 25° C placed in a moist chamber composed of plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol, and examined at regular intervals for the presence of microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of $\times 1000$. Micrographs were obtained with a Zeiss Axioskop 40 microscope, Leitz Dialux 20 EB microscope and a Jeol JSM-6400 scanning electron microscope using the techniques described previously by Figueras & Guarro (1988).

Taxonomy

Phaeocandelabrum R.F. Castañeda, Gusmão, Guarro & Iturr., **anam. gen. nov.**

MYCOBANK MB 39222

FIGS. 1-8

COLONIAE in substrato naturali effusae, nigrae. Mycelium partim superficiale et partim in substrato immersum. *CONIDIOPHORA* macronemata, mononemata, erecta, septata, laevia vel verrucucosa, brunnea, sed dilute brunnea ad usque apicem. *CELLULAE* CONIDIOGENAE

*hologenosae, uniloculosae, determinatae vel indeterminatae cum pluribus proliferationibus enteroblasticis percurrentibus, in conidiophoris incorporatae. Loci conidiogeni apicales. SECESSIO CONIDIORUM rhexolytica. CONIDIA solitaria, pluriramosa, complicata, brunnea vel atrobrunnea, irregularia, pyramidalia, globosa vel in forma plus minusve litterae Graecae upsilon; ex conformationibus: (i) 2–7 cellulis centralibus hemisphaericis, globosis, turbinatis usque ad doliformibus, aequilateralibus vel inaequalibus, brunneis; (ii) 8–18 alter cellulis hemisphaericis globosis, coronatis vel plus minusve induplicativis, diminutis cum ramulis dichotomis, aspecto lobulatis vel interdum diminutis ramis simplicibus vel dichotome tuberculatis vel lobulatis usque ad radiatis, dilute brunneis vel subhyalinis ad apicem praedita (iii) nonnunquam 2–4 cellulis tertiis similibus conformatis, ex cellulis secundis orientibus. SYNANAMORPHA ad genus *Selenosporella* similis, nonnunquam cellulis conidiogenis, hologenosis, multiloculosis, sympodialibus, indeterminatis in diminutis ramulis dichotome orientibus quae tollunt conidia fusiformia, unicellularia, hyalina. Teleomorphosis ignota.*

ETYMOLOGY: Greek, *phaeo-*, meaning dark-colored; Latin, *-candelabrum*, referring to a hyphomycete genus (*Candelabrum*).

SPECIES TYPICA: *Phaeocandelabrum elegans* (R.F. Castañeda) comb. nov.

COLONIES on the natural substrate effuse, epiphyllous, sometimes amphigenous, hairy, brown or black. MYCELIUM superficial and immersed. CONIDIOPHORES macronematous, mononematous, erect, straight, septate, smooth or verruculose, brown below to pale brown towards the apex. CONIDIOGENOUS CELLS monoblastic, terminal, integrated, determinate or indeterminate with several enteroblastic percurrent proliferations. CONIDIAL SECESSION rhexolytic. CONIDIA solitary, acrogenous, complex, multi-cellular, branched, irregular, pyramidal, turbinate, globose to Y-shaped, brown to dark brown to dark brown with a basal frill, composed of: i) 2–7 hemispherical, globose, turbinate to doliiform central cells, equilateral or unequal, brown to dark brown ii) 8–18 hemispherical, globose, crowded to induplicate secondary cells with minute dichotomous tubercles or slightly lobed to radial, pale brown to subhyaline, iii) 2–4 hemispherical, crowned or with short dichotomous tubercles tertiary cells sometimes arise from secondary cells. SYNANAMORPH *Selenosporella*-like, arising from the tubercles of tertiary cells. Conidia holoblastic, fusiform, unicellular, hyaline.

NOTES. The genera *Arachnophora* Hennebert, *Candelabrum* Beverw., *Polyancora* Voglmayr & Yule and *Sopagraha* Subram. & Sudha can be compared with *Phaeocandelabrum* in conidium ontogeny, the shape of conidia, particularly in terms of the number of cells of the main body, and their ramification and ornamentation. *Arachnophora* is clearly distinguished by a central body with 2 brown to dark brown cells, each of which bears several lateral somewhat conical protuberances which themselves each have 1 or several straight or inwardly curved, pale brown or hyaline arms (Hennebert 1963, Castañeda et al. 1997, Castañeda & Guarro 1998, Becerra et al. 2009). Although conidium ontogeny and conidial secession are similar in both genera, configuration of

the conidia is clearly different from *Phaeocandelabrum*. In *Candelabrum* each conidium consists of a more or less H-shaped main body of 4 to several hyaline to subhyaline, smooth central cells and 8 to many lateral cells which grow centrifugally from each central cell, becoming repeatedly dichotomously or trichotomously branched in 3 dimensions with ultimate cells also dichotomous or trichotomous and subhyaline with minute tubercles (Matsushima 1996, Voglmayr 1998). The genus *Sopagraha* is characterized by conidia with 2–3 dark brown central cells, which produce 4–12 secondary hemispherical, dome-shaped cells called “primary satellite cells” (Subramanian & Sudha 1979), which usually arise from the two upper cells and rarely from the basal cell, and 1–4 hemispherical, hyaline tertiary cells laterally borne from secondary cells called “secondary satellite” cells. The conidial secession is considered to be rhexolytic and Subramanian & Sudha (1979) remarked that the “conidia do not secede from the conidiophores; in fact, detached conidia carry along with them longer or shorter portion of the conidiophores on which they were produced.” Conidiophores are macronematous, mononematous, simple or branched and putative conidiogenous cells are discrete and determinate; these features of conidiogenesis separate *Sopagraha* from *Phaeocandelabrum*. *Polyancora*, recently described by Voglmayr & Yule (2006), has multicellular, globose conidia consisting of three distinct elements: (1) repeatedly centrifugally branching globose central cells, (2) an outermost globose cell that gives rise to (3) several much thinner, elongated, radially oriented cylindrical cells branching several times at the tip, the branchlets being very thin, going off at more or less right angles apically from the cylindrical cell, and arched, resulting in branchlet tips often touching other branchlets or other cylindrical cell tips. The schizolytic conidial secession and hyaline or subhyaline structures clearly differentiates *Sopagraha* from *Phaeocandelabrum*.

***Phaeocandelabrum elegans* (R.F. Castañeda) R.F. Castañeda, Heredia & Saikawa, comb. nov.** FIGS 1–11, 31

MYCOBANK MB511006

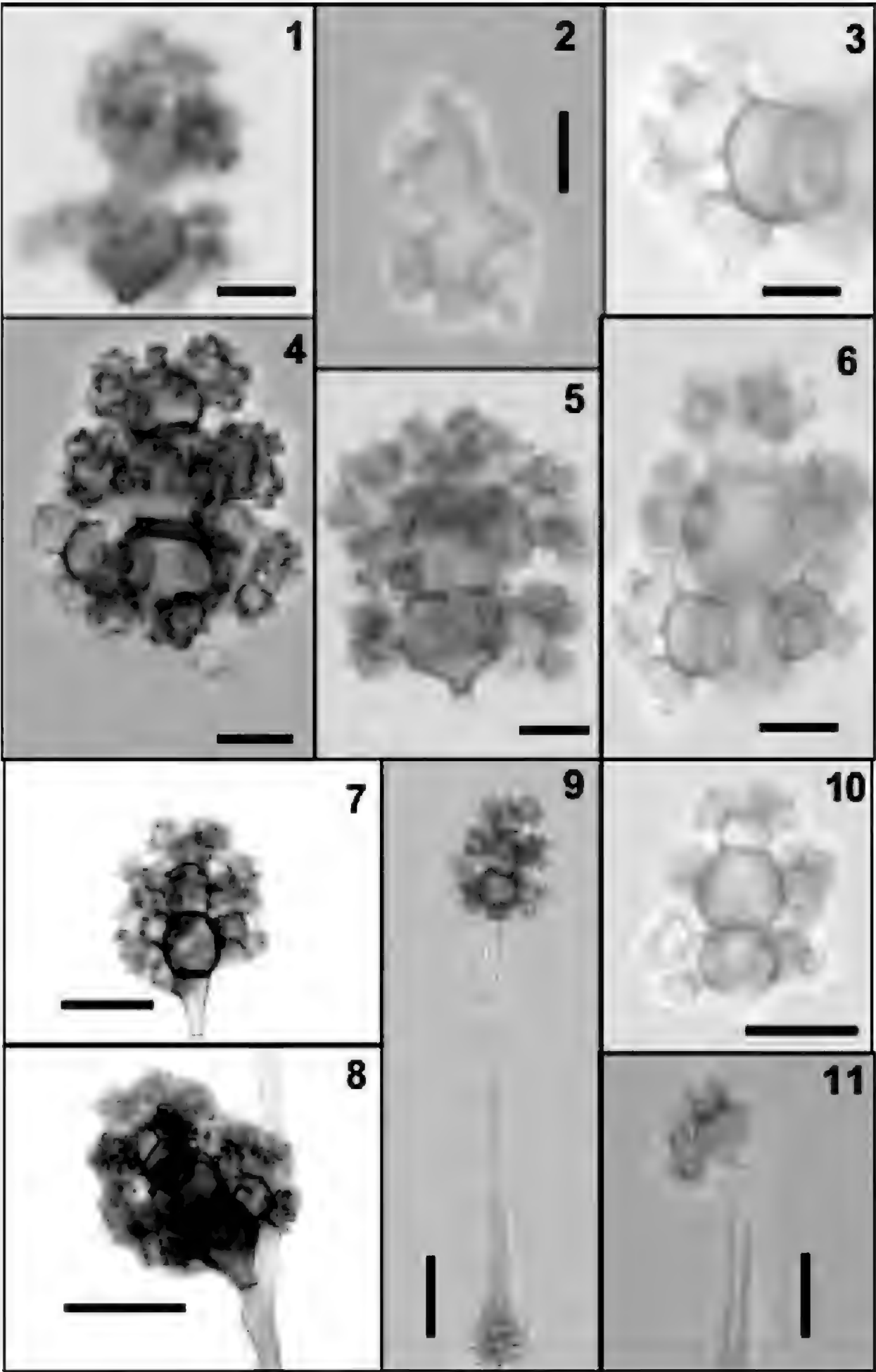
BASIONYM: *Sopagraha elegans* R.F. Castañeda, Deuteromycotina de Cuba.

Hyphomycetes II. p 13 (1985), Instituto de Investigaciones Fundamentales en Agricultura Tropical “Alejandro de Humboldt”, Cuba.

COLONIES on the natural substrate effuse, epiphyllous, sometimes amphigenous, hairy, brown. MYCELIUM superficial and immersed. Hyphae septate, branched,

FIGS. 1–11. *Phaeocandelabrum elegans*, photomicrographs from holotype (INIFAT C84/97) and XAL CB079–1. FIGS. 1–3. Tertiary cells with dichotomous tubercular protuberances. FIGS. 4–6, 9–11. Conidiophores and conidiogenous cells and conidia from holotype (INIFAT C84/97). FIGS. 7–8. Conidia from (XAL CB079–1).

Scale is indicated by bars. (FIGS 1–6: 10 µm, FIGS 7,8 and 10: 20 µm, FIGS 9 and 11: 40 µm).



2.0–3.5 μm diam., smooth-walled, brown. CONIDIOPHORES conspicuous, mononematous, erect, straight, 2- to 5-septate, smooth-walled, up to 200 μm tall, 5–7 μm wide, brown below, pale brown towards the apex. CONIDIOGENOUS CELLS monoblastic, terminal, cylindrical, determinate, integrated, sometimes indeterminate with 2 or 3 enteroblastic percurrent proliferations, 14–18 \times 2.5–5.0 μm , pale brown, smooth-walled. CONIDIAL SECESSION rhexolytic. CONIDIA solitary, acrogenous, more less pyramidal, sometimes slightly turbinate, 33–37 \times 24–30 μm , brown, dry, with a basal frill 1–2 μm long, complex, composed of: i) 3 globose to hemispherical cells, gradually smaller towards the apex, 10.5–14.5 \times 10–12 μm , brown to dark brown, but basal cell somewhat turbinate; ii) 8–12 hemispherical secondary cells, 6–8 μm wide, pale brown to brown; iii) 1–3 tertiary hemispherical cells crowned, 3.5–5 μm wide, with 3–5 short dichotomous tubercles or lobes, pale brown to subhyaline. SYNANAMORPH *Selenosporella*-like, arising from the tubercles of tertiary cells. Conidia holoblastic, fusiform, unicellular, 2.5–4.5 \times 0.5–1 μm , hyaline, smooth.

SPECIMENS EXAMINED: CUBA. CIUDAD DE LA HABANA. SANTIAGO DE LAS VEGAS, on decaying leaves of *Cedrela mexicana* M.J. Roem., 16.X.1984. R.F. Castañeda (HOLOTYPE: INIFAT C84/97). MEXICO. VERACRUZ, ESTACIÓN BIOLÓGICA DE LA MANCHA, Municipio Actopan, Selva mediana, on decaying leaves of an unidentified plant, 2.VIII.1995, G. Heredia (XAL CB079–1).

Phaeocandelabrum callisporum Gusmão, A.C. Cruz & R.F. Castañeda, **sp. nov.**

MYCOBANK MB511005

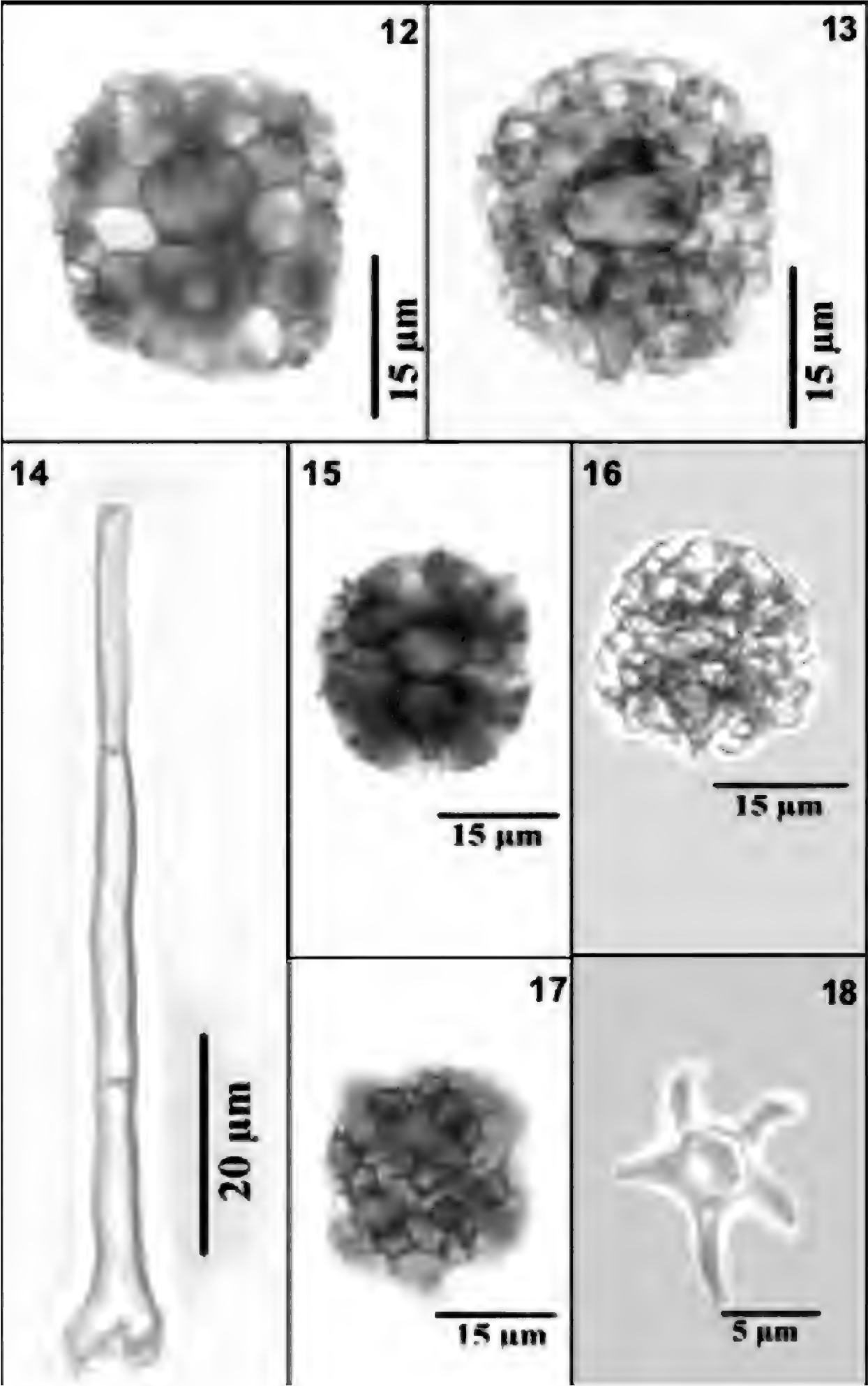
FIGS 12–18, 32

COLONIAE in substrato naturali effusae, pilosae, amphigenae, brunneae CONIDIOPHORA macronemata, mononemata, 2–6-septata, 67–150 \times 6–9 μm , brunnea et pallidiora ad apicem. CELLULAE CONIDIOGENAE hologenosae, uniloculosae, 14–42 \times 2–4 μm , integratae, determinatae vel indeterminatae cum proliferationibus enteroblasticis percurrentibus, pallide brunneis. CONIDIA solitaria, pluriramosa, complicata, globosa vel bihemisphaerica, plus minusve aequilateralibus, 26–36 \times 25–32 μm , brunneis, siccis, compositis ab (i) 2 cellulis hemisphaericis vel globosis, cellula basali licet sit turbinata, 10–13 \times 9–13 μm cum reliquiis cellularum conidiogenarum 1.2–6.6 μm ; cellula suprabasalis hemisphaerica, 9–12 \times 10.2–13.8 μm , brunnea; (ii) 7–10 cellulis secundariis plus minusve doliiformibus, 4–9 \times 4–7 μm ; (iii) 3–4 cellulis hemisphaericis, plus minusve induplicativis, stellatis 9–10 μm diam., cum 5 ramulis radialibus, dilute brunneis vel subhyalinis, circa apicem cellulis secundariis dispositis. Teleomorphosis ignota.

TYPE: BRAZIL. BAHIA, Palmeiras, VALE DO CAPÃO, on decaying leaves of *Cupania paniculata* Cambess. (*Sapindaceae*), 24.VI.2000. L.F.P. Gusmão (HOLOTYPE: HUEFS 56701).

ETYMOLOGY: Greek, *calli* - meaning pretty and elegant; - *sporus* - referring to the conidia.

FIGS. 12–18. *Phaeocandelabrum callisporum*, photomicrographs from holotype (HUEFS 56701). FIGS. 12–13, 15–17. Conidia with a frill. FIG. 14. Conidiophore and conidiogenous cell. FIG. 18. Induplicative, stellate tertiary cell. Scale is indicated by bars.



COLONIES on the natural substrate effuse, hairy, amphigenous, brown. MYCELIUM superficial and immersed; hyphae septate, branched, 2.0–3.5 μm diam., smooth-walled, pale brown to brown. CONIDIOPHORES macronematous, mononematous, erect, straight, 2- to 6-septate, smooth-walled, 67–150 \times 6–9 μm , brown at the base, pale brown towards the apex. CONIDIOGENOUS CELLS monoblastic, terminal, cylindrical, determinate, integrated, 14–42 \times 2–4 μm , sometimes indeterminate with 2 enteroblastic percurrent proliferations, pale brown, smooth-walled. CONIDIA solitary, acrogenous, branched, globose or bi-hemispherical, more less equilateral, 26–36 \times 25–32 μm , brown, with turbinate basal cell and a basal frill 1.2–6.6 μm long, complex, composed of: i) 2 brown to dark brown, hemispherical to globose central cells, 10–13 \times 9–13 μm ; ii) 7–10 pale brown to pale brown, more less doliiform secondary cells, 4–9 \times 4–7 μm ; iii) 3–4 stellate tertiary hemispherical cells, 9–10 μm diam with 5 radial, subhyaline to pale brown projections. Teleomorph unknown.

ADDITIONAL SPECIMEN EXAMINED: BRAZIL. BAHIA, SENHOR DO BONFIM, on decaying leaves of an unidentified dicotyledonous plant, 28.IX.2006. A.C.R. Cruz, HUEFS 120873.

Phaeocandelabrum joseiturriagae R.F. Casteñeda, Iturr., Heredia & M. Stadler,

sp. nov.

FIGS 19–24, 25–30, 33

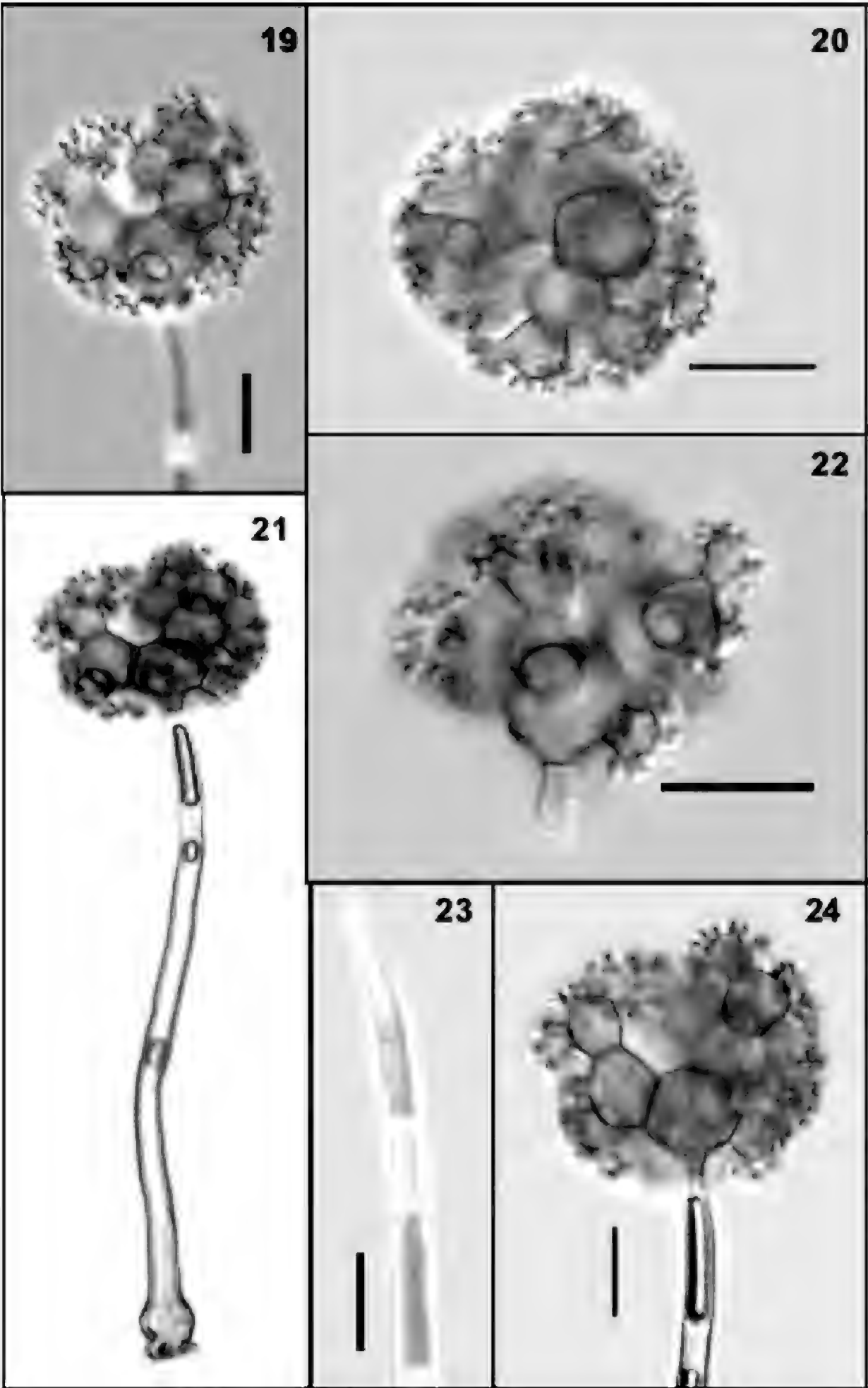
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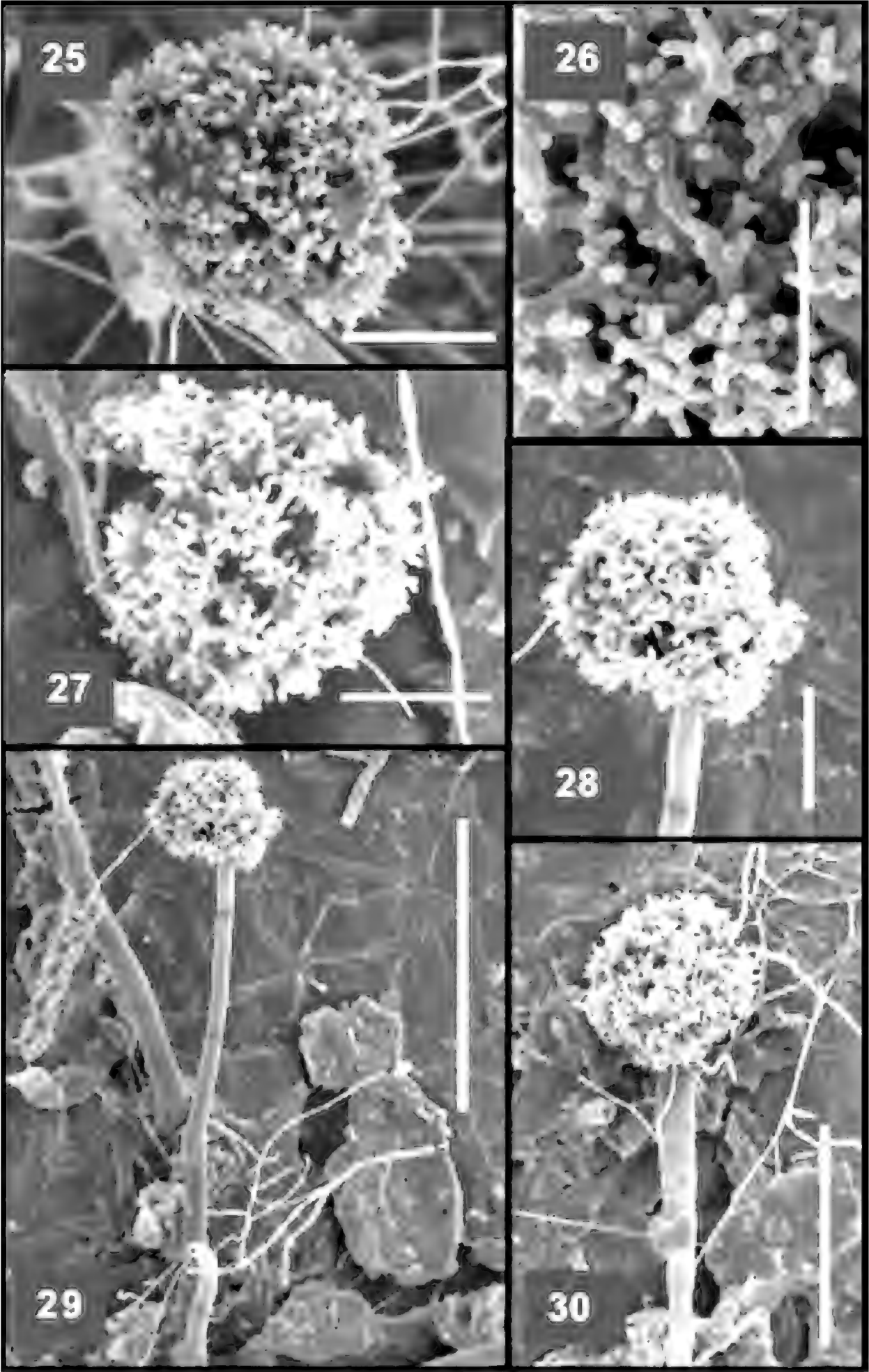
COLONIAE in substrato naturali effusae, pilosae, plerumque hypophyllae, brunneae. CONIDIOPHORA macronemata, mononemata, 3- ad 4- septata, 60–110 \times 5–7 μm , brunnea. CELLULAE CONIDIOGENAE hologenosae, uniloculosae, 7.2–12 \times 3.6–4.0 μm , integratae, determinatae vel indeterminatae cum proliferationibus enteroblasticis percurrentibus, brunneis et dilute brunneis ad apicem. CONIDIA solitaria, pluriramosa, complicata, brunnea, irregularia, plus minusve in forma litterae Graecae upsilon, in summa 24–30 \times 24.4–33.6 μm , brunnea sed dilute brunnea ad marginem, composita ab: (i) 5–7 cellulis centralibus hemisphaericis ad subglobosis, aequilateralibus vel inaequalibus sed cellulis basalibus turbinate, 9.6–13.2 \times 9.6–14.4 μm , brunneis; cum reliquiis cellulae conidiogenae 1.5–2.6 μm ; (ii) 8–14 cellulis secundariis hemisphaericis vel globosis, 7.2–9.6 \times 8.4–9.2 μm , cum diminutis tuberculis dichotomis vel trichotomis, dilute brunneis vel subhyalinis ad marginem praeditis; (iii) nonnunquam 2–4 cellulis tertiis similibus conformatis, 6.0–6.6 \times 7.0–7.6 μm ex cellulis secundariis orientibus. Teleomorphosis ignota.

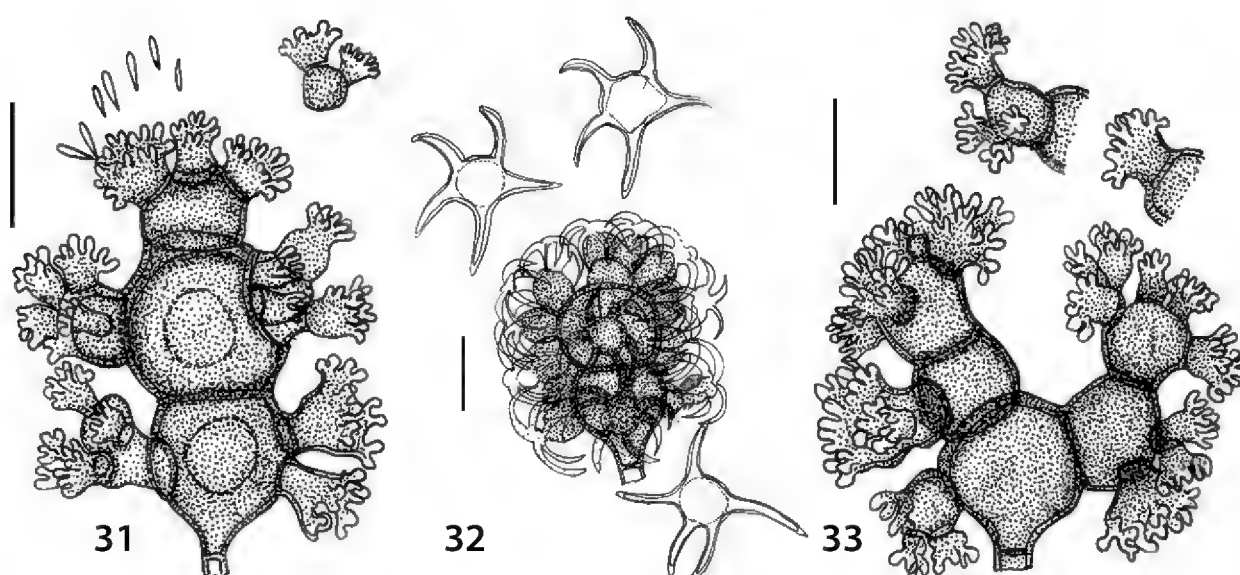
TYPE: BRAZIL. RIO DE JANEIRO, “MORRO DO CORCOVADO”, on decaying leaves of an unidentified plant, 12.X.2002. J. Guarro and A.M. Stichgel (HOLOTYPE: CBS H-6587a).

ETYMOLOGY: Latin, *joseiturriagae* – in honour of José F. Iturriaga, an important mentor to Venezuelan mycology, and father to T. Iturriaga.

FIGS. 19–24. *Phaeocandelabrum joseiturriagae*, photomicrographs from holotype (CBS H-6587a). FIGS. 19–21, 24. Conidiophore, conidiogenous cell and conidia. FIG. 22–23. Conidia with a frill and conidiogenous cell. Scale bars 10 μm .







FIGS. 31–33. Conidia and tertiary cells in *Phaeocandelabrum* spp. Scale bars = 10 μ m.

FIG. 31. *P. elegans* (INIFAT C84/97, holotype). Conidium with *Selenosporella*-like synanamorph and tertiary cell with dichotomous tubercles. FIG. 32. *P. callisporum* (HUEFS 56701, holotype). Conidium and induplicative, stellate tertiary cells. FIG. 33. *P. joseiturriagae* (CBS H-6587a, holotype). Conidium and tertiary cell with dichotomous tubercles.

COLONIES on the natural substrate effuse, hairy, mostly hypophyllous, brown. MYCELIUM superficial and immersed. Hyphae septate, branched, 1.0–2.5 μ m diam., smooth-walled, pale brown to brown. CONIDIOPHORES macronematous, mononematous, erect, straight or slightly sinuate, 3- to 4-septate, inflated and somewhat lobed at the base, smooth-walled, 60–110 \times 5–7 μ m, brown below, pale brown towards the apex. CONIDIOGENOUS CELLS monoblastic, terminal, cylindrical, determinate, integrated, sometimes indeterminate with 2–3 enteroblastic percurrent proliferations, 7.2–12 \times 3.6–4.0 μ m, pale brown, smooth-walled. CONIDIA solitary, acrogenous, branched, more less broadly Y-shaped to irregular, 24–30 \times 24.4–33.6 μ m, brown, but pale brown at margin, complex, composed of: i) 5–7 hemispherical to subglobose, equilateral or unequal central cells, 9.6–13.2 \times 9.6–14.4 μ m, basal cell somewhat turbinate, brown, with a frill 1.5–2.6 μ m long; ii) 8–14 hemispherical or globose secondary cells, 7.2–9.6 \times 8.4–9.2 μ m, pale brown to brown, with 3–5 dichotomous or trichotomous, pale brown to subhyaline minute tubercles at the apex; iii) sometimes 2–4 crowded tertiary hemispherical cells, 6.0–6.6 \times 7.0–7.6 μ m, arising from the secondary cells with 3–5 dichotomously or trichotomously branched minute tubercles near the apex. Teleomorph unknown.

FIGS. 25–30 (left). *Phaeocandelabrum joseiturriagae*, photomicrographs (SEM) from holotype (CBS H-6587a). FIGS. 25–26. Conidia showing the tertiary cells with dichotomous or trichotomous tubercles. FIGS. 27–30. Conidiogenous cells and conidia.

Scale bars: FIGS. 25, 27–28 = 10 μ m; FIG. 26 = 8 μ m; FIG. 29 = 50 μ m; FIG. 30 = 30 μ m.

ADDITIONAL SPECIMENS EXAMINED: ISOTYPES: HUEFS120867 and INIFAT C02 /89. VENEZUELA. ESTADO ARAGUA, "COLONIA TOVAR", on decaying leaves of an unidentified plant, 25.XI.2000. T. Iturriaga and R.F. Casteñeda, USB C00/ 92 = CBS 109477.

Acknowledgements

We are deeply indebted to Prof. Lori M. Carris (Washington State University) and Dr. Mary Palm (APHIS, United States Department of Agriculture) for kindly reviewing the manuscript. We thank the Cuban Ministry of Agriculture for facilities, and UK Darwin Initiative and Universidad Simón Bolívar, Venezuela, for support. The author RFCR thanks Pedro Crous, Uwe Braun, Ludmila Marvanová, Cony Decock, Jerry A. Cooper, Rosa M. Arias, and Josep Cano for their generous and valued assistance with literature not otherwise available. The author LFP Gusmão thanks CNPq (proc. 471619/2004).

Literature cited

- Becerra Hernández CI, Heredia Abarca H, Arias Mota RM, Mena Portales J, Casteñeda Ruiz RF. 2009. Especies raras de hongos anamorfos saprobios en el estado de Tabasco. *Revista Mexicana de Micología*. 28: (in press).
- Casteñeda Ruiz RF. 1985. Deuteromycotina de Cuba. *Hyphomycetes* II. p 13 (1985), Instituto de Investigaciones Fundamentales en Agricultura Tropical "Alejandro de Humboldt", Cuba, 23 pp.
- Casteñeda Ruiz RF, Gams W, Saikawa M. 1997. Three new conidial fungi (hyphomycetes) from Cuba. *Nova Hedwigia* 64: 473–483.
- Casteñeda Ruiz RF, Guarro J. 1998. Two new hyphomycetes from rainforests from Cuba. *Can. J. Bot.* 76: 1584–1588.
- Figueras MJ, Guarro J. 1988. A scanning electron microscopic study of ascoma development in *Chaetomium malaysiense*. *Mycologia* 80: 298–306.
- Hennebert GL. 1963. Un hyphomycète nouveau, *Arachnophora fagicola* gen. nov. sp. nov. *Can. J. Bot.* 41: 1165–1169.
- Matsushima T. 1996. Matsushima Mycological Memoirs No. 9: 1–30 + 70 plates.
- Subramanian CV, Sudha K. 1979. *Sopagraha sibika*, a new hyphomycete from leaf litter from India. *Can. J. Bot.* 57: 34–39.
- Voglmayr H. 1998. *Candelabrum desmidiaceum* and *Candelabrum clathrosphaeroides* spp. nov., additions and keys to *Candelabrum*. *Mycol. Res.* 102: 410–414.
- Voglmayr H, Yule CM. 2006. *Polyancora globosa* gen. sp. nov. an aeroaquatic fungus from Malaysian peat swamp forests. *Mycol. Res.* 110: 1242–1252.

The genus *Sowerbyella* (Pezizales) in China

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Abstract — Studies on collections of *Sowerbyella* resulted in recognition of four species of the genus in China. A new species, *S. laevispora*, on mossy soil in *Picea* forest from Qinghai Province in northwestern China is described and illustrated. It is similar to *S. rhenana* in apothecial shape and anatomic structure, and distinct from that fungus in wider and shorter ascospores and shorter asci, and from all known species of the genus by its smooth-walled ascospores.

Key words — morphology, SEM, taxonomy

Introduction

Sowerbyella Nannf., a well defined genus of *Pyronemataceae*, contains a group of fungi with bright colored, cupulate and stipitate apothecia, angular cells in ectal excipulum with short hyphoid cell extensions or minute pustules on outer surface, interwoven hyphae in medullary excipulum, a well- to poorly-developed subhymenium, operculate asci, and ornamented ascospores (Moravec 1988a, Yao & Spooner, 2006). About eleven or twelve species have commonly been recognized in the world. Apothecial shape, size and color, ascospore shape, size and type of ornamentations are important criteria in taxonomy of the genus.

The genus was first reported from China by Korf & Zhuang (1985) with a single species from Sichuan Province as *Aleuria rhenana* Fuckel. It was later transferred to *Sowerbyella* by Moravec (1986). Additional species discovered were *S. radiculata* from Qinghai Province (Zhuang 1998) and *S. angustispora* from Jilin Province (Moravec 1988a). The latter was later erroneously recorded from Beijing and Qinghai as “*S. fagicola* J. Moravec” (Zhuang & Wang 1997, Zhuang 1998). This recent study of the genus reports a new species distinguished by its smooth-walled ascospores.

Material and methods

Old and recent collections of *Sowerbyella* from China on deposit in the Mycological Herbarium, Chinese Academy of Sciences (HMAS) and

Cryptogamic Herbarium, Kunming Institute of Botany, Chinese Academy of Sciences (HKAS) were examined. Apothecia were rehydrated and sectioned by a freezing microtome (YD-1508A, Yidi Medical Instrument Co., Jinhua, China) at the thickness of 20–25 μm . Measurements were taken from sections mounted in cotton blue-lactophenol solution and from squash mounts. For SEM study of the spore surface morphology, a portion of hymenium was cut and stuck directly on a stub. The materials were coated with gold-palladium and observed with SEM (FEI Quanta 200). Photographs were taken with a digital camera (Canon G5, Tokyo, Japan) connected with a microscope (Zeiss Axioskop 2 plus).

Taxonomy

Sowerbyella angustispora J.Z. Cao & J. Moravec, in Moravec, Mycol. Helvet. 3(1): 136, 1988.

SPECIMENS EXAMINED: CHINA. Beijing, Mount. Baihua, on the ground in forest, 18-XI-1995, W.Y. Zhuang & Z. Wang 1197, HMAS 70323; Beijing, Mount. Baihua, on the ground in forest, 20-XI-1995, W.Y. Zhuang & Z. Wang 1254, 1256, 1267, HMAS 70324, 70325, 70326; Qinghai, Qilian, on the ground, 3-VIII-1996, X.L. Mao & S.X. Sun 9307, HMAS 71958. (previously filed under *Sowerbyella fagicola*)

NOTES: This is a very characteristic fungus and featured by its small, fusoid-ellipsoid and narrow ascospores ($12\text{--}15.5 \times 4.8\text{--}7 \mu\text{m}$) with minute, separate, conical ornamentations on the spore surface (Moravec 1988a,b). A detailed description and illustrations of the fungus were provided by the original authors. Unfortunately the holotype specimen from Jilin Province, China seems very difficult or impossible to locate. This fungus is relatively common in the northern part of China but has not been reported from any other country.

The previous Chinese records of *Sowerbyella fagicola*, a fungus with a similar spore shape to *S. angustispora* but with larger ascospores, based on collections from Beijing and Qinghai, were misidentifications (Zhuang & Wang 1997, Zhuang 1998). Re-examinations of the above specimens indicate that the correct name for these collections is *S. angustispora*.

Sowerbyella laevispora W.Y. Zhuang, sp. nov.

FIGS 1–6

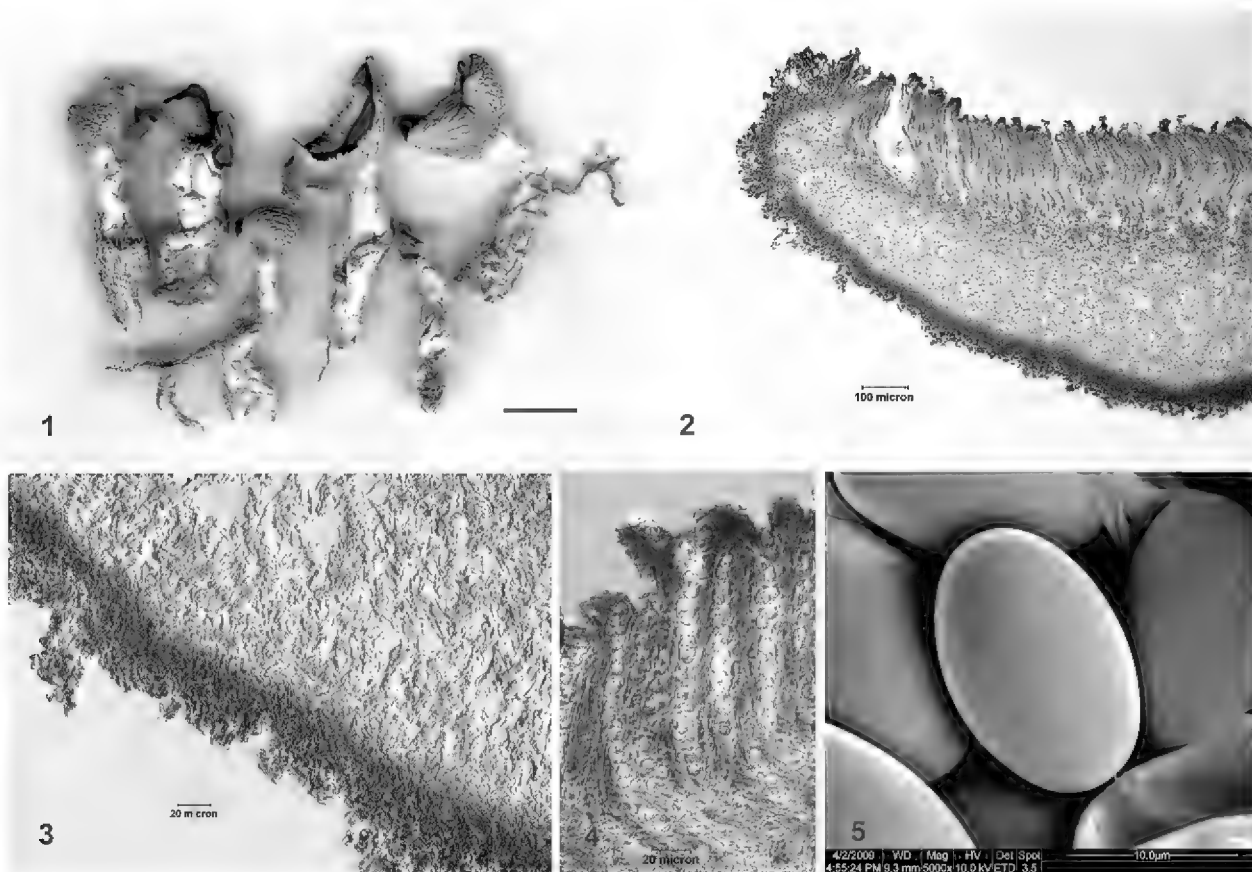
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Apotheciis cupulatis, stipitatis; ascis cylindricis, 8-sporis, $216\text{--}262 \times 14\text{--}16 \mu\text{m}$; ascosporis ellipsoideis, laevibus, $17\text{--}20.5 \times 10\text{--}13.5 \mu\text{m}$.

HOLOTYPE: CHINA. Qinghai, Huangcheng, on mossy soil in *Picea* forest, 9-IX-1958, Q.M. Ma 1039, HMAS 33796 (previously filed under *Aleuria rhenana*).

ETYMOLOGY: refers to the smooth ascospore surface morphology.

Dried apothecia deep-cupulate, long-stipitate, 8–16 mm in diam., hymenium surface brown, receptacle surface orange-brown, stipe dirty cream, up to 25 mm



FIGS 1–5. *Sowerbyella laevispora* (from holotype): 1. Dried apothecia, scale bar = 12 mm; 2. Portion of apothecium in longitudinal section; 3. Anatomic structure of excipulum; 4. Portion of hymenium showing asci with ascospores; 5. SEM of ascospores showing surface morphology.

long and 5–9 mm wide, with 2–4 longitudinal shallow furrows; ectal excipulum of textura angularis, 45–75 μm thick (excluding cell extensions), with short, hyphoid cell extensions on surface, cells angular, isodiametric to ellipsoidal, thin-walled, subhyaline, 20–50 \times 16–38 μm , cell extensions or minute pustules 20–35 μm high; medullary excipulum of textura intricata, 200–410 μm thick or even thicker, hyphae thin-walled, hyaline, 3–9 μm wide; subhymenium poorly developed, 0–20 μm thick; hymenium 250–280 μm thick; asci subcylindrical, 8-spored, J– in Melzer’s reagent, 216–262 \times 14–16 μm ; ascospores ellipsoid to broadly ellipsoid, hyaline, smooth, unicellular, biguttulate, uniseriate, 17–20.5 \times 10–13.5 μm ; paraphyses filiform, septate, 3–4 μm wide at apex and 2–3 μm below.

NOTES: As commonly accepted, *Sowerbyella* contains species with ascospore surface ornamented without exceptions (Moravec 1988a, Yao & Spooner 2006). The new species possesses all the features of the genus except for its smooth-walled ascospores. To avoid establishing a new genus based on a single character, the generic concept is thus extended to accommodate species having smooth ascospores.

The type specimen of *S. laevispora* was previously filed under “*Aleuria rhenana*”, which indicates that the new species is similar to *S. rhenana* in gross

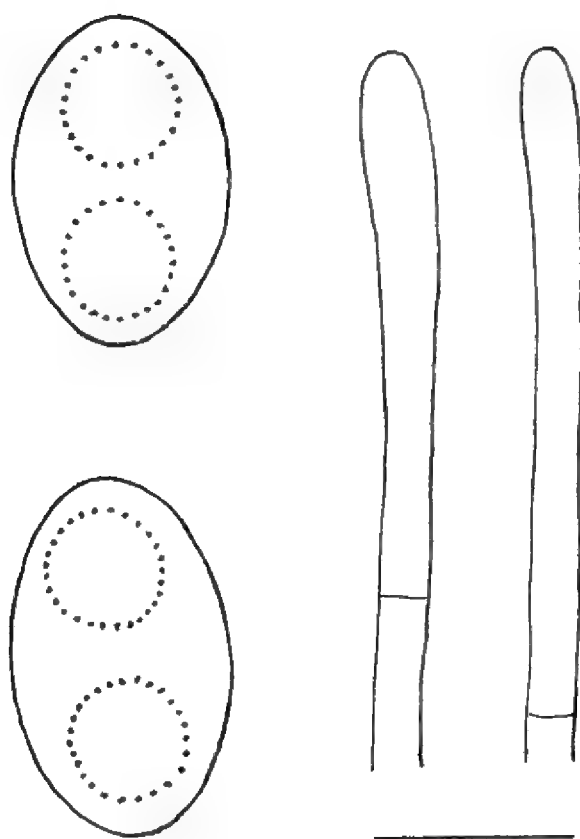


FIG 6. *Sowerbyella laevispora* (from holotype):
Ascospores and paraphysis apices. Scale bar = 10 μm .

morphology. But observation under light microscope and SEM study reveal that its ascospores are wider and shorter than those of *S. rhenana* [$17\text{--}20.5 \times 10\text{--}13.5 \mu\text{m}$ vs. $18\text{--}23.6(26.3) \times 9\text{--}11.8 \mu\text{m}$] and smooth-walled instead of possessing characteristic reticulate spore markings, and its asci are shorter ($216\text{--}262 \times 14\text{--}16 \mu\text{m}$ vs. $270\text{--}350 \times 11\text{--}15 \mu\text{m}$) (Rifai 1968).

Sowerbyella radiculata (Sowerby) Nannf., Svensk Bot. Tidskr. 32: 119, 1938.

≡ *Peziza radiculata* Sowerby, Col. Fig. Engl. Fung. Mushr. 1: pl. 114, 1797.

≡ *Lachnea radiculata* (Sowerby) W. Phillips, Man. Brit. Discomyc. p. 202, 1887.

≡ *Pseudotis radiculata* (Sowerby) Boud., Hist. Class. Discom. Eur. p. 52, 1907.

SPECIMEN EXAMINED: CHINA. Qinghai, Qilian, on the ground in forest, 13-VIII-1996, X.L. Mao & S.X. Sun 9294, HMAS 71957.

Sowerbyella rhenana (Fuckel) J. Moravec, Mycol. Helv. 2(1): 96, 1986.

≡ *Aleuria rhenana* Fuckel, Jb. Nassau. Ver. Naturk. 23–24: 325, 1870.

SPECIMENS EXAMINED: CHINA. Sichuan, Derong, Jinsha River, on the ground in forest, 16-VIII-1981, X.J. Li, HKAS 8644, HMAS 72008; Sichuan, on the ground in forest, 7-VIII-1981, X.J. Li, HMAS 58211; Qinghai, Datong, on the ground in forest, 13-VIII-1996, X.L. Mao & S.X. Sun 9249, 9302, HMAS 71959, 71960; Qinghai, Datong, on the

ground in forest, 14-VIII-1996, J. Y. Zhuang 5684, HMAS 71970; Qinghai, Menyuan, on mossy soil under *Picea* forest, 19-VIII-2004, W.Y. Zhuang & C.Y. Liu 5410, HMAS 97556.

Acknowledgments

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Literature cited

- Korf RP, Zhuang WY. 1985. Some new species and new records of discomycetes in China. *Mycotaxon* 22: 483–514.
- Moravec J. 1986. A new species and two new combinations in the genus *Sowerbyella*. *Mycol. Helvet.* 2: 93–102.
- Moravec J. 1988a. A key to the species of *Sowerbyella* (*Discomycetes*, *Pezizales*). *Česká Mykol.* 42: 193–199.
- Moravec J. 1988b. *Sowerbyella angustispora* sp. nov. and *Otideopsis kaushalii* comb. nov. (*Discomycetes*, *Pezizales*, *Pyronemataceae*). *Mycol. Helvet.* 3: 135–142.
- Rifai MA. 1968. The Australasian *Pezizales* in the Herbarium of the Royal Botanic Gardens, Kew. *Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk. Tweede, Sect.* 57(3): 1–295.
- Yao YJ, Spooner BM. 2006. Species of *Sowerbyella* in the British Isles, with validation of *Pseudombrophila* sect. *Nannfeldtiella* (*Pezizales*). *Fungal Divers.* 22: 267–279.
- Zhuang WY. 1998. Notes on discomycetes from Qinghai Province, China. *Mycotaxon* 66: 439–444.
- Zhuang WY, Wang Z. 1997. Some new species and new records of discomycetes in China. VII. *Mycotaxon* 63: 307–321.

***Lichenochora atrans* (Phyllachoraceae), a new lichenicolous species on *Psora decipiens* from Turkey**

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Abstract — *Lichenochora atrans* sp. nov. is described on terricolous *Psora decipiens* from western Turkey. It is the fourth species of the genus that has simple ascospores. The other three species, *L. collematum*, *L. thorii* and *L. verrucicola*, have much smaller ascospores in size, and only *L. thorii* has pigmented mature ascospores like *L. atrans*. *Lichenochora atrans* is also unique in the genus by having largest ascomata and ascospores.

Key words — *Ascomycota*, lichenicolous fungi, lichens

Introduction

Lichenochora Hafellner in *Phyllachoraceae* (Lumbsch & Huhndorf 2007) is a common genus of lichenicolous fungi currently containing 31 species (Hafellner 1989, Etayo & Navarro-Rosinés 2008, Etayo & Sancho 2008, Zhurbenko 2008). A key to the genus was recently published (Etayo & Navarro-Rosinés 2008) comprising 30 species, not including the recently published *L. thorii* Zhurb.

The genus has perithecia with thin walls of round to polygonal cells formed of two layers, the outer dark, the interior hyaline. They are gall-forming in some species and the mycelium is dark or hyaline, immersed in thallus of the host. The exciple hyphae around the ostiole in many species form prominent papillae or hyphal appendages. The hamathecium consists of periphyses and delicate paraphyses. The paraphyses are branching or not, often as thick as 8 µm, and usually dissolving in mature perithecia. The ascal wall and hymenial gel are I – and the ascomatal cavity is inspersed with lipid drops. Asci are functionally

unitunicate, stalked, with 2 to 8 ascospores per ascus. Ascospores are hyaline, non-septate to pluriseptate, of various shape and sizes, sometimes with a perispore that can be pigmented, the ascospores appearing shades of gray to brown. The genus is specific to particular genera or groups of species within a genus.

We describe a new species of *Lichenochora* from Turkey on *Psora decipiens*. It is the fourth species with non-septate ascospores and the perispore is pigmented dark brown in mature ascospores. We first considered placing this new taxon in *Roselliniella*, which has many species with simple dark ascospores as well as several species with ascospores larger or as large such as *R. africana* Diederich (Aptroot et al. 1997) or *R. cladoniae* (Anzi) Matzer & Hafellner (Matzer & Hafellner 1990) and has thick vegetative hyphae, two-walled ascomata, a hamathecium with periphyses and thick paraphyses, lacks papillae and hyphal appendages around the ostiole, and can have paraphyses with abundant lipid drops (Matzer & Hafellner 1990). But our taxon contained abundant lipid drops in the wall and cavity of the ascomata as do all *Lichenochora*, which also have thick vegetative hyphae, two-walled ascomata, and a hamathecium with periphyses and thick paraphyses.

As first proposed, *Lichenochora* incorporated two species that may develop light brown 1-septate ascospores when over-mature — *L. galligena* R. Sant. & Hafellner and *L. polycoccoides* Hafellner & R. Sant. (Hafellner 1989). Hoffmann & Hafellner (2000) emended *Lichenochora* to include species with simple ascospores, while adding *Lichenochora thorii* Zhurbenko (2008) incorporated species with ascospores that are olive-brown when mature. Our taxon's perispore first matures to an olive-green (like *L. thorii*) but then becomes a darker brown. The first species lacking papillae or hyphal appendages in the ostiole region was *L. mediterraneae* Calat. et al. (Calatayud et al. 2000). Considering these developments in the concept of the genus *Lichenochora*, we placed our new taxon in *Lichenochora*. Nonetheless, while studying both *Lichenochora* and *Roselliniella* we have begun to question the systematic placement of *Lichenochora* in *Phyllachoraceae* while *Roselliniella* is placed in the *Sordariales* among the genera incertae sedis (Lumbsch & Huhndorf 2007).

Material and methods

The type material of the new species is deposited in ANES. Specimens were examined with an Olympus BH-2 research microscope fitted with Nomarski differential interference contrast optics and a drawing tube. Photomicrographs were prepared on a Nikon Eclipse 80i. Sections were prepared by hand and examined in I (Merck Lugol's iodine and water. Ascospore measurements were made in water. Ascospore and asci measurements were given as: (min.) (X–SD) –X– (X + SD) (max.), where min. and max. are the extreme values, X = the

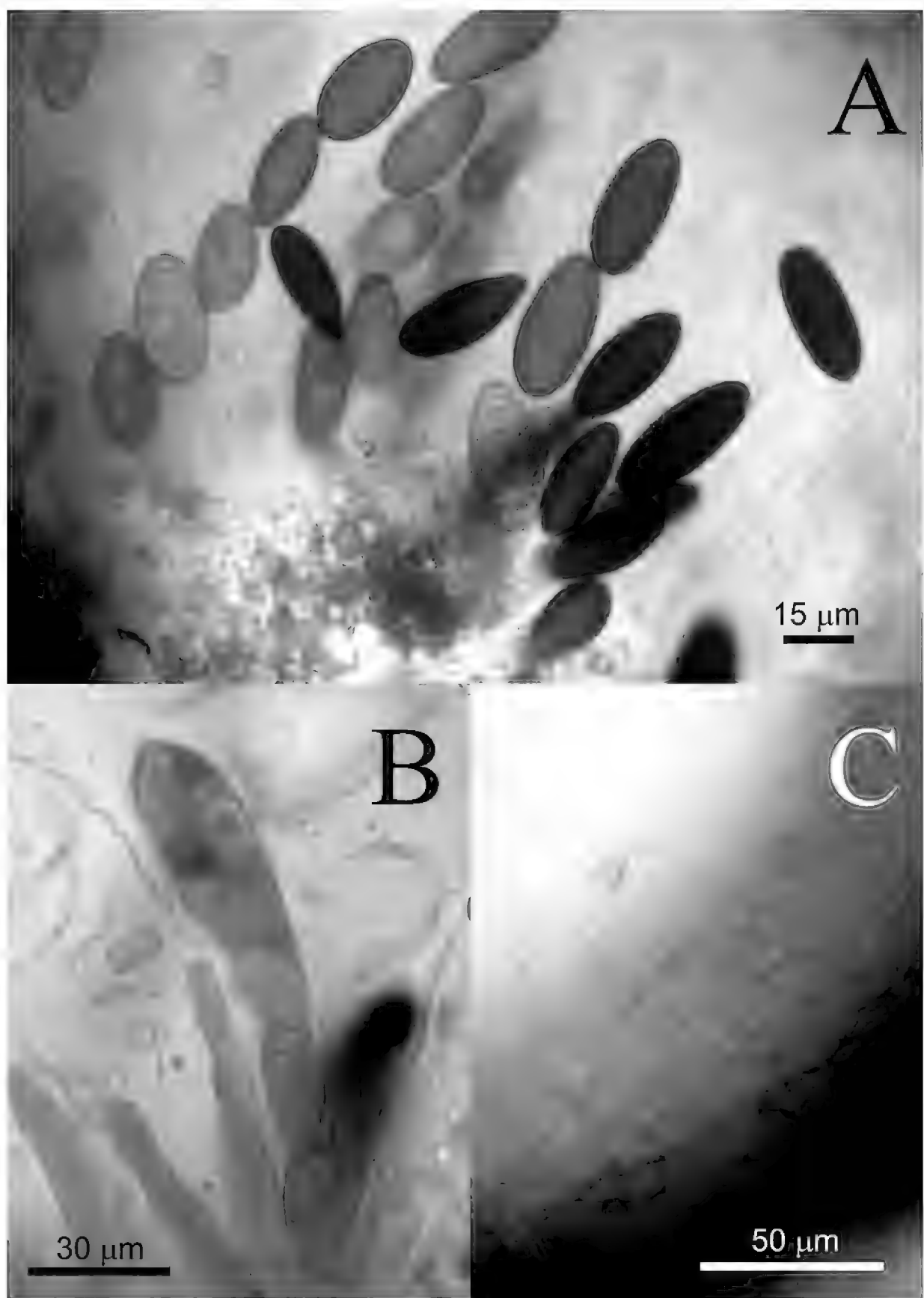


FIG. 1. *Lichenochora atrans* (holotype). A, Ascospores; B, 6-spored ascus in I; C, Ascomata walls and lipid droplets.

arithmetic mean, and SD = the corresponding standard division. The length/breadth ratio of ascospore is indicated as l/b and given in the same way.

The species

Lichenochora atrans Halici, K. Knudsen & Candan, sp. nov.

FIGURE 1

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Fungus lichenicola. Speciei *Lichenochora thorii similis*, sed differt in ascomatibus et ascosporis majoribus. Ascomata 400–600 μm diam. et ascosporae (30–)31.75–36.5–41.25(–48) \times (13–)14–16–18(–21) μm .

TYPE: Turkey, Afyon, Sandıklı, South-west of Celiloğlu Village, open area, 38°22'N, 30°08'E, alt. 1250 m, on thallus of *Psora decipiens* on soil, 5 June 2008, leg. M. Candan (ANES 12279 – holotype).

ETYMOLOGY: The specific name refers to the darkening of the perispore in mature ascospores.

DESCRIPTION: Lichenicolous, on the margins of the squamules and on underside of the squamules of *Psora decipiens*, not forming galls. VEGETATIVE HYPHAE immersed, reddish brown, 4–5 μm in diameter. ASCOMATA perithecioid, arising singly, immersed with only the ostiole and surrounding zone externally visible, to semi-immersed, 400–600 μm diam., black, subglobose to pyriform. EXCIPLE pseudoparenchymatous, 30–50(–60) μm thick, evenly thickened throughout; in vertical section through the ostiole, made up of two different layers: the outer one dark reddish brown, with 4–7 layers of tangentially flattened isodiametric cells, and the inner one, pale brown to colourless, with 4–6 layers of cells; (5–) 7–10 \times (3–)5–8(–9) μm in size, with lipid droplets in various sizes in almost all cells, especially in the colourless cells. No papillae or hyphal appendages observed. HYMENIUM colourless, I –, with abundant lipid droplets relatively large, 4–8(–10) μm diam. HAMATHECIUM made up of periphyses and paraphyses.Periphyses persistent, mostly unbranched, abundant along all the ostiolar channel, 15–20 \times 3–5 μm . Paraphyses 4–6.5 μm thick, septate, simple or ramified, with many lipid droplets inside, only visible among immature asci, dissolving in mature perithecia. ASCI cylindrical-clavate, with a thin wall, not or almost not thickened at the apex, shortly stalked, unitunicate, 8-spored in the young asci, 4–6-spored in the mature asci, epiplasm dextrinoid, I + orange-red, (70–)89–104–119(–125) \times (15–)16–19–22(–25) μm ($n = 20$). ASCOSPORES \pm uniseriately arranged in the mature asci, ellipsoid, non-septate, usually one large lipid droplet and many small lipid droplets present, perispore present, smooth, pigmented dark brown in mature ascospores, rounded to somewhat broadly pointed at the apices, (30–)31.75–36.5–41.25(–48) \times (13–)14–16–18(–21) μm ($n = 40$), l/b = (1.75–)2.02–2.26–2.50(–2.90), all measurements and ratio including the perispore. CONIDIOMATA not observed.

ECOLOGY AND DISTRIBUTION: *Lichenochora atrans* seems to be parasymbiotic as no damage to the host lichen was observed, but more collections are necessary to confirm this. The species is only known from the type locality. The type locality has a typical step vegetation with relict *Quercus* trees. The host

lichen, *Psora decipiens* is abundant on the open soil between small siliceous rocks. Other terricolous lichens occur with *Psora decipiens* including *Aspicilia hispida*, *A. desertorum*, *Cetraria aculeata*, *Cladonia foliacea*, *Diploschistes muscorum*, *Acarospora schleicheri* (parasitic on *Diploschistes muscorum*), and *Xanthoparmelia pokornyi* in the type locality.

OBSERVATIONS: *Lichenochora atrans* is the first species of the genus recognized on the host lichen family *Psoraceae*.

Only three other *Lichenochora* species have simple ascospores: *L. collematum* Nik. Hoffm. & Hafellner, *L. thorii* Zhurb. and *L. verrucicola* (Wedd.) Nik. Hoffm. & Hafellner (Etayo & Navarro-Rosinés 2008, Hoffmann & Hafellner 2000, Zhurbenko 2008). *L. collematum* and *L. verrucicola* differ from *L. atrans* by their gall-inducing life habit on different lichen hosts and colourless ascospores of much smaller sizes. *L. thorii*, a recently described parasymbiotic species on *Aspicilia moenium* has also simple and pigmented ascospores, but this species differs from *L. atrans* in having much smaller ascospores [(10–)13.5–15.5–17.5(–22) × (4–)4.5–5–5.5(–6.5) µm vs. (30–)31.75–36.5–41.25(–48) × (13–)14–16–18(–21) µm] and much smaller ascomata [150–300 µm vs. 400–600 µm] (Zhurbenko 2008).

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Literature cited

- Aptroot A, Diederich P, Sérusiaux E, Sipman HJM. 1997. Lichens and Lichenicolous Fungi from New Guinea. *Bibliotheca Lichenologica*, 64: 1–220.
- Calatayud V, Navarro-Rosinés P, Calvo E. 2000. *Lichenochora mediterraneae* (Phyllachorales, Ascomycota), a new lichenicolous fungus from Spain. *Lichenologist* 32(3): 225–231.
- Etayo J, Navarro-Rosinés P. 2008. Una combinación y tres especies nuevas de *Lichenochora* (Phyllachorales, Ascomycetes liquenícolas), y notas adicionales para el género. *Revista Catalana de Micología* 30: 27–44.
- Etayo J, Sancho LG. 2008. Hongos liquenícolas del Sur de Sudamérica, especialmente de Isla Navarino (Chile). *Bibliotheca Lichenologica* 98: 1–302.
- Hafellner J. 1989. Studien über lichenicole Pilze und Flechten VII. Über die neue Gattung *Lichenochora* (Ascomycetes, Phyllachorales). *Nova Hedwigia* 48: 357–370.
- Hoffmann N, Hafellner J. 2000. Eine Revision der lichenicolen Arten der Sammelgattungen *Guignardia* und *Physalospora* (Ascomycotina). *Bibliotheca Lichenologica* 77: 1–180.
- Lumbsch HT, Huhndorf SM. (eds.) 2007. Outline of *Ascomycota* – 2007. *Myconet* 13: 1–58.
- Matzer M, Hafellner J. 1990. Eine Revision der lichenicolen Arten der Sammelgattung *Rosellinia* (Ascomycetes). *Bibliotheca Lichenologica* 37: 1–138.
- Zhurbenko M. 2008. *Lichenochora thorii* (Phyllachorales), a new lichenicolous *ascomycete* from Europe. *Nova Hedwigia* 87: 509–512.

Three nomenclatural corrections for species of *Hypocrea*/*Trichoderma*

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Abstract — Three hypocreoid taxa were found to be illegitimate later homonyms of previously described species. Hence, the replacement names, *Hypocrea straminella* (= *Hypocrea straminea* P. Chaverri & Samuels), *Trichoderma pseudocandidum* (= *Trichoderma candidum* P. Chaverri & Samuels), and *Trichoderma pseudonigrovirens* (= *Trichoderma nigrovirens* P. Chaverri & Samuels), are provided.

Key words — Ascomycota, Hypocreaceae, Hypocreales, nomen novum, nomenclature

Introduction

Hypocrea Fr. (anamorph *Trichoderma* Pers.) is a genus of ubiquitous fungi, some of which are exploited in commercial applications including biological control, industrial enzyme production, and bioremediation (Chaverri & Samuels 2003). In a previous systematic treatment of species with green ascospores, Chaverri & Samuels (2003) described several taxonomic novelties. Unfortunately, some of them were subsequently found to be illegitimate names according to the International Code of Botanical Nomenclature (McNeill et al. 2006), since they are later homonyms of previously described but somewhat obscure taxa. According to McNeill et al. (2006), a nomen novum is needed for each name, and we prefer to assign the following replacement names before the use of the illegitimate names has become prevalent in the literature.

Taxonomy

Hypocrea straminella P. Chaverri, Samuels & Minnis, **nom. nov.**

MYCOBANK MB 513342

= *Hypocrea straminea* P. Chaverri & Samuels, *Studies in Mycology*: 48: 86, 2003,
non *Hypocrea straminea* Petch, *Ann. Roy. Bot. Gard. (Peradeniya)* 7: 97, 1920.

The anamorph of this fungus is *Trichoderma stramineum* P. Chaverri & Samuels (Chaverri & Samuels 2003).

***Trichoderma pseudocandidum* P. Chaverri, Samuels & Minnis, nom. nov.**

MYCOBANK MB 513343

≡ *Trichoderma candidum* P. Chaverri & Samuels, Studies in Mycology 48: 40, 2003, non *Trichoderma candidum* Alb. & Schwein.,
Conspectus Fungorum in Lusatiae Superioris: 137, 1805.

The teleomorph of this fungus is *Hypocrea candida* P. Chaverri & Samuels (Chaverri & Samuels 2003).

***Trichoderma pseudonigrovirens* P. Chaverri, Samuels & Minnis, nom. nov.**

MYCOBANK MB 513344

≡ *Trichoderma nigrovirens* P. Chaverri & Samuels, Studies in Mycology 48: 78, 2003,
non *Trichoderma nigrovirens* Goddard, Bot. Gaz. 56: 273, 1913, “nigro-virens”.

The teleomorph of this fungus is *Hypocrea nigrovirens* P. Chaverri & Samuels (Chaverri & Samuels 2003).

Acknowledgments

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Literature cited

- Albertini JB, Schweinitz LD von. 1805. Conspectus Fungorum in Lusatiae Superioris. Lipsiae, Sumtibus Kummerianis. 376 p.
- Chaverri P, Samuels GJ. 2003. *Hypocrea/Trichoderma* (Ascomycota, Hypocreales, Hypocreaceae): species with green ascospores. Studies in Mycology 48: 1–116.
- Goddard HN. 1913. Can fungi living in agricultural soil assimilate free nitrogen? Bot. Gaz. 56: 249–305.
- McNeill J, Barrie FR, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema JH, Turland NJ (eds.). 2006. International Code of Botanical Nomenclature (Vienna Code): Adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. A.R.G. Gantner Verlag, Ruggell. 568 p.
- Petch T. 1920. *Hypocreaceae* Zeylanicae. Ann. Roy. Bot. Gard. (Peradeniya) 7: 85–138.

***Arthrobotrys nonseptata*, a new anamorph from an *Orbilia* species**

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Abstract — A new species of nematophagous fungi, *Arthrobotrys nonseptata*, was isolated from an unidentified *Orbilia* species. *Arthrobotrys nonseptata* produces simple, erect, unbranched conidiophores with conspicuous denticles at their tip, the conidia being nonseptate, ovoid to elongate ellipsoid. In the presence of nematodes, it forms three-dimensional adhesive networks.

Key words — nematode-trapping fungi, teleomorph–anamorph connection

Introduction

Nematophagous fungi destroy nematodes using several kinds of trapping devices: stalked and sessile adhesive knobs, two- or three- dimensional adhesive nets, and constricting and non-constricting hyphal rings. Those with adhesive nets are referred to form genus *Arthrobotrys* Corda which includes about 50 species (Scholler et al. 1999).

Pfister was the first to connect an *Arthrobotrys* species with a teleomorph of the ascomycetous genus *Orbilia* (1994). So far, five *Arthrobotrys* species have been linked with teleomorphs, including *O. auricolor* (A. Bloxam ex Berk.) Sacc. with four anamorphs, *A. oligospora* Fresen. and *A. cladodes* Drechsler (Pfister 1995), *A. yunnanensis* M.H. Mo & K.Q. Zhang (Mo et al. 2005), *A. psychrophila* (Drechsler) M. Scholler et al. (Rubner 1996, as *Monacrosporium psychrophilum*); and *O. fimicola* Jeng & J.C. Krug and its anamorph *A. superba* Corda (Pfister 1994). In our survey of *Orbilia* species and their anamorphs, an *Arthrobotrys* species was isolated from an unidentified *Orbilia* species. This isolate could not be assigned to any previously described species and is described here as a new species, *Arthrobotrys nonseptata*.

* These authors contributed to this work equally.

Materials and methods

Collection of teleomorph, Isolation and characterization of the anamorph

Fresh specimens of an *Orbilina* species were collected on decaying bark of a broad-leaved tree, located in DaLongKou Park of Yimen County (N24°34', E101°00', at 1580 m altitude, in a coniferous-broadleaf forest including primarily *Cyclobalanopsis glaucoides* Schottky and *Pinus armandii* Franch.), Yunnan Province, China, on 18 August, 2006 by Y. Zhang. A dried voucher specimen was deposited in the Laboratory for Conservation and Utilization of Bio-resource, Yunnan Province, China. (YMFT1.01852). To isolate its anamorph, several fresh apothecia were fixed to the lid of a Petri-dish with their hymenia upside down so that shooting ascospores were deposited on the surface of CMA (20 g corn meal, 18 g agar, 40 mg streptomycin, 30 mg ampicillin, 1000 ml distilled water). The Petri-dishes with apothecia were left 4–6 days at room temperature until deposits of ascospores were visible on the CMA. Agar blocks with deposits of ascospores were transferred to another CMA plate to avoid contamination. After incubation for 7–10 days at 25°C, conidiophores and conidia were observed. All cultures produced the same anamorph. Microscopic characters were observed and measured with an Olympus B51 microscope with differential interference contrast and a Zeiss Standard 20 microscope. Trapping organs were induced by adding about 100 nematodes (*Panagrellus redivivus* Goodey) to a 1 × 1 cm square slot at the margins of the colony created by removing the agar.

DNA extraction, PCR, and sequencing

Total DNA was isolated from fresh mycelium as described by Turner et al. (1997). Primer pairs ITS4 and ITS5 (White et al. 1990) were used to amplify the complete ITS (including 5.8S). The parameters for PCR amplifications were those used by Yu et al. (2006). The PCR products were purified with a commercial Kit (Bioteke Biotechnology Co., Ltd., China). Both strands were sequenced using the primers that were used for amplification. Sequencing was done on an LI-COR 4000L automatic sequencing system, using cycle sequencing with the ThermoSequenase kit as described by Kindermann et al. (1998).

Phylogenetic analysis

We performed a parsimony analysis using ITS sequences of allied species of *Arthrobotrys*, and also of *Dactylellina* and *Drechslerella*. These latter species produce networks, adhesive knobs, and constricting rings, respectively. Genbank accession numbers are shown in our phylogenetic tree.

DNA sequences were aligned using ClustalX 1.83. Parsimony analysis was run in PAUP* 4.0b10 (Swofford 2002). Gaps were treated as missing data, all characters were equally weighted, initial 'MaxTrees' setting was 100, all trees were obtained by running the heuristic searches with tree-bisection-reconnection (TBR) as branch-swapping algorithm and up to 1000 random-addition sequence replications. To assess the relative support for each clade, bootstrap values were calculated from 10 replicate analyses with the heuristic search strategy and random addition sequence of the taxa.

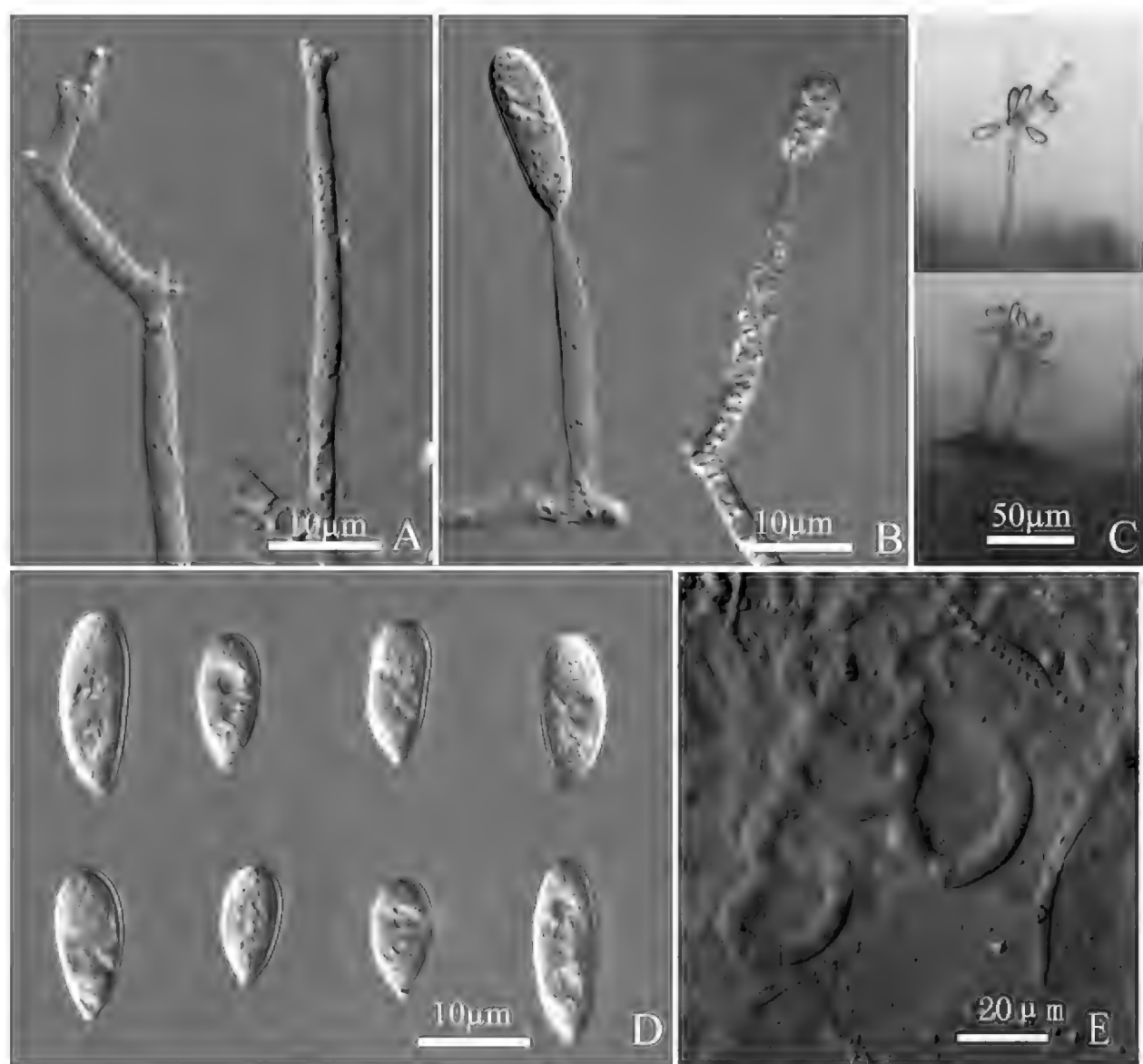


PLATE 1. *Arthrobotrys nonseptata* (YMF1.01852) A. Conidiophores with short denticles. B. Conidium attached to a conidiophore. C. Conidiophores bearing conidia in clusters. D. Conidia. E. Adhesive nets.

Results

Taxonomic description

Arthrobotrys nonseptata Z.F. Yu, S.F. Li & K.Q. Zhang, sp. nov. PLATE 1
MYCOBANK MB 512349

Coloniae in agaro albae, post 10 dies 25°C ad 35 mm diam. Mycelium sparsum, hyphis septatis, 3.5–4 µm latis. Conidiophora erecta, septata, non ramosa, 40–120 µm longa, 2–4 µm lata ad basim, 1.5–2 µm lata ad apicem, efferentia 3–10 conidia de retrogressis conidiogenis locis in latis perspicuis dendriculis in apice aut prope apicem. Conidia hyalina, elongate ellipsoidea, non-septata, 11–16.8 × 5–6.6 µm cum parvo truncatotubere in base. Reticula tenacia quae vermiculos nematodeos capiunt evolventivus.

HOLOTYPE: YMF 1.01852, permanent slide, Yimen County, DaLongkou Forest Park, Yunnan Province, PR China, Ze Fen Yu, Aug 18. 2006.

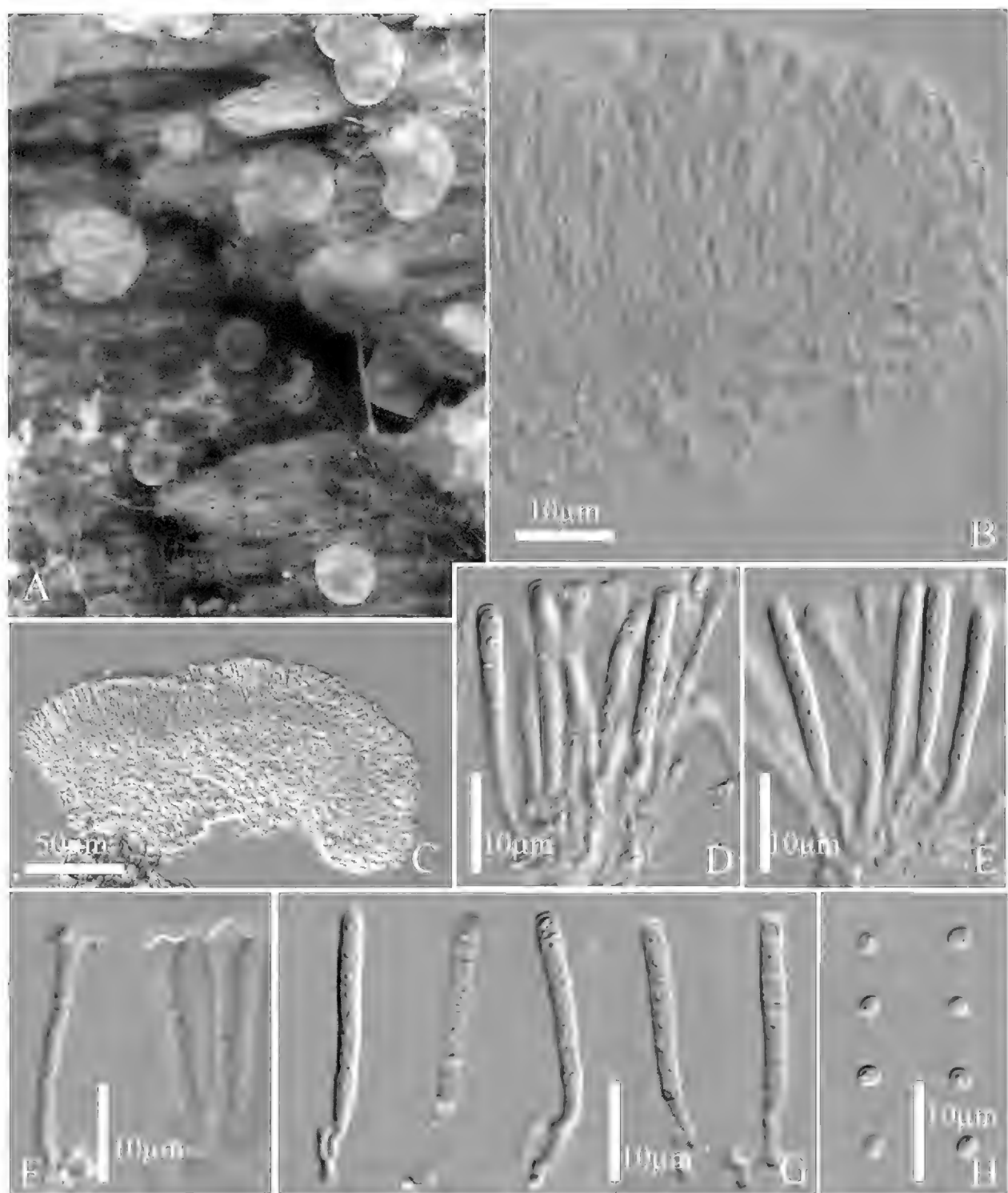


PLATE 2. *Orbilia* sp. (YMFT 1.01852) A. Apothecia. B. Cells of ectal excipulum. C. Vertical section of part apothecia. D-E. Cluster of dead asci and paraphyses with living spores. F. Paraphyses. G. Asci. H. Ascospores.

ASSUMED TELEOMORPH: an unidentified species of *Orbilia* (PLATE 2), YMFT 1.01852, collected on decaying bark of a broad-leaved tree, DaLongKou Park, Yimen County, alt.1580 m, Yunnan Province, PR China, Ying Zhang. 18 August, 2006.

ETYMOLOGY: The species epithet refers to the nonseptate conidia.

Colonies slow-growing on CMA medium, attaining less than 35 mm diam. in 10 days at 25°C. Vegetative hyphae hyaline, septate, 3.5–4 µm wide, aerial

mycelium sparse, hyaline, septate, branched, 2.5–4 µm wide. Conidiophores erect, septate, unbranched, 40–120 µm high, 2–4 µm wide in the lower part, 1.5–2 µm wide at the tip, producing 3–10 conidia from retrogressive conidiogenous loci on conspicuous denticles at and near the apex. Conidia hyaline, nonseptate, 11–16.8 × 5–6.6 µm, elongate ellipsoid, constricted at the base by forming a small truncate protuberance. Nematodes are captured by means of three-dimensional adhesive networks.

Phylogenetic analysis

Parsimony analysis of the ITS sequences yielded a single most parsimonious tree based on 192 parsimony-informative characters (147 constant characters, 206 uninformative characters). The MP tree had 890 steps in length with a consistency index (CI) of 0.6697 and a retention index (RI) of 0.5859. Our analysis used *Dactylella clavata* (a non-predacious member of the family Orbiliaceae) as outgroup. In the tree predacious species were divided into three clades. Strains with networks, constricting rings, and adhesive knobs formed A, B and C groups respectively, which is consistent with the results from Hagedorn & Scholler (1999) and Li et al. (2005). Our isolate of *A. nonseptata* falls into clade A, which is consistent with the production of adhesive networks.

Discussion

There are four known species of *Arthrobotrys* with nonseptate or occasionally uniseptate conidia. Conidia of *A. amerospora* (Schenck et al. 1977) are consistently nonseptate, while those of *A. anomala* (Barron & Davidson 1972), *A. botryospora* (Barron 1979) and *A. yunnanensis* (Mo et al. 2005) are occasionally uniseptate. *A. nonseptata* differs from these four species in conidial shape and size. *A. nonseptata* most closely resembles *A. yunnanensis* in regard to conidial shape. Both species were isolated from ascospores of *Orbilia* sp. The conidia of both are variable in shape and partly elongate or ellipsoid. In addition, the denticles of *A. yunnanensis* are longer than those of *A. nonseptata*. Other differences between *A. nonseptata* and the four known species are summarized in TABLE 1.

Results inferred from ITS sequence analyses support all five species discussed above in the same clade A. Although all have the same type of trapping device, the five species are distinct. Morphological and molecular characters serve to distinguish the species.

Arthrobotrys teleomorphs have, as far as known, narrow falcate ascospores usually referred to *O. auricolor* agg. However, the unidentified *Orbilia* species from which the present isolate derives has broadly ellipsoid ~2.5–3 µm long ascospores. In this character it resembles *O. orientalis* (Raitv.) Baral, which is

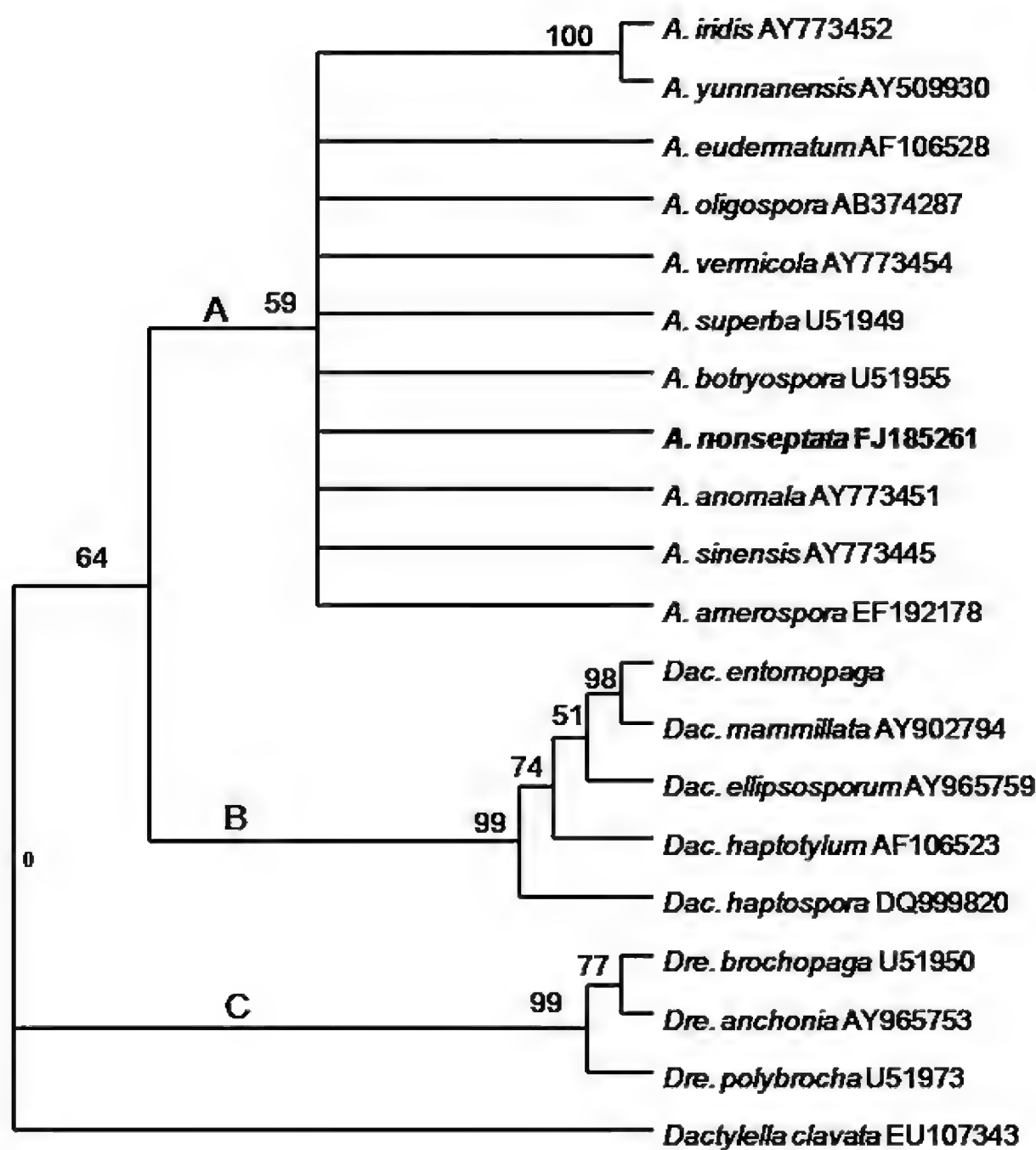


PLATE 3. Most parsimonious phylogenetic tree generated from a heuristic search based on the alignment of the ITS region sequences of some predacious species. Numbers above lines represent bootstrap values from 1000 replicates on all parsimony-informative characters; only values >50% shown. Clade A includes members with adhesive nets; clade B includes members with constricting rings; clade C includes members with adhesive knobs.

connected to a *Drechslerella* anamorph with much longer, 3-septate conidia and constricting rings (Yu et al. 2006). For this reason, although *A. nonseptata* was isolated from the undescribed *Orbilia* collection, we hesitate to recognise them as an established anamorph–teleomorph pair. We hope that future isolations from this teleomorph will confirm or refute the relationship.

TABLE 1. Morphological comparison of *Arthrobotrys anomala*, *A. botryospora*, *A. amerospora*, *A. yunnanensis*, and *A. nonseptata*

CHARACTERS	<i>A. anomala</i>	<i>A. amerospora</i>	<i>A. botryospora</i>	<i>A. yunnanensis</i>	<i>A. nonseptata</i>
CONIDIA					
Shape	cylindric to elongate ellipsoidal	obovoid	ellipsoidal	elongate, ellipsoid- cylindrical, or sl. clavate	elongate ellipsoidal
Size (µm)	13–22 × 3–7	15–31 × 10–20	12–20 × 11–15	17.5–32.5 × 2.75–7.5	11–16.8 × 5–6.6
Septation	0(–1)	0	0(–1)	0(–1)	0
CONIDIOGENOUS CELL					
Denticle	short	short	short	long	short
CONIDIOPHORE					
Height (µm)	20–80	75–250	250–450	60–200	40–120

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Literature cited

Barron GL, Davidson JGN. 1972. Nematophagous hyphomycetes: *Arthrobotrys anomala* sp. nov. Canadian Journal Botany 50: 1773–1774.

Barron GL. 1979. Nematophagous fungi: a new *Arthrobotrys* with non-septate conidia. Canadian Journal Botany 57: 1371–1373.

Kindermann J, El-Ayouti Y, Samuels GJ, Kubicek CP. 1998. Phylogeny of the genus *Trichoderma* based on sequence analysis of the internal transcribed spacer region 1 of the rDNA clade. Fungal Genetic Biology 24: 298–309.

Mo MH, Huang XW, Zhou W, Huang Y, Hao YE, Zhang KQ. 2005. *Arthrobotrys yunnanensis* sp. nov., the fourth anamorph of *Orbilia auricolor*. Fungal Diversity 18: 107–115.

Pfister DH. 1994. *Orbilia fimicola*, a nematophagous discomycete and its *Arthrobotrys* anamorph. Mycologia 86: 451–453.

Pfister DH, Liftik ME. 1995. Two *Arthrobotrys* anamorphs from *Orbilia auricolor*. Mycologia 87: 684–688.

Rubner A. 1996. Revision of predacious hyphomycetes in the *Dactylella-Monacrosporium* complex. Studies in Mycology 39: 1–134.

Scholler M, Hagedorn G, Rubner A. 1999. A reevaluation of predatory orbiliaceous fungi. II. A new generic concept. Sydowia 51: 89–113.

- Schenck S, Kendrick WB, Pramer D. 1977. A new nematode-trapping hyphomycete and a reevaluation of *Dactylaria* and *Arthrobotrys*. Canadian Journal Botany 55: 977–985.
- Swofford DL. 2002. PAUP*. Phylogenetic analysis using parsimony, Version 4.0. Sinauer Associates, Sunderland, Massachusetts, USA.
- Turner D, Kovacs W, Kuhls K, Lieckfeldt E, Peter B, Arisan-Atac I, Strauss J, Samuels GJ, Börner T, Kubicek CP. 1997. Biogeography and phenotypic variation in *Trichoderma* sect. *Longibrachiatum* and associated *Hypocrea* species. Mycological Research 101: 449–459
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: PCR Protocols: a guide to methods and applications. Academic Press, San Diego. CA, p 315–322.
- Yu ZF, Zhang Y, Qiao M, Baral HO, Weber E, Zhang KQ. 2006. *Drechlerella brochopaga*, the anamorph of *Orbilina (Hyalinia) orientalis*. Mycotaxon 96:163–168.

A white species of *Volvariella* (Basidiomycota, Agaricales) from southern China

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Abstract — A new white agaric, *Volvariella nivea*, discovered in Guangzhou of China is formally introduced. Similar species are compared, and morphological characters and the rDNA ITS sequence of the new species differ from all other taxa placed in *Volvariella*. The holotype is deposited in the Herbarium of Microbiology Institute of Guangdong (GDGM).

Key word — *Pluteaceae*, taxonomy

Introduction

Spegazzini (1899) established *Volvariella* Speg. to accommodate species with pink basidiospores, free lamellae, and a stipe lacking an annulus but encased by a basal volva. Many species have been transferred to this genus from several genera, including *Volvaria* (Fr.) P. Kumm., *Volvariopsis* Murrill, *Pseudofarinaceus* Earle, *Agaricus* L., and *Pluteus* Fr. New taxa are regularly being reported from tropical, subtropical and temperate regions of both eastern and western hemispheres. Until now, 111 species names have been recorded (www.Indexfungorum.org), including 19 species reported from China (Teng 1963, Tai 1979, He & Feng 1987, Bi et al. 1993, 1997, MEXM 1997, Mao 1997, Huang 1998). In 2008, a *Volvariella* species was collected from Baiyun Mountain in Guangzhou Municipality of China that differs from previously named species. The new species is formally described below.

* corresponding author

Materials and methods

Specimens were annotated and photographed in the field, dried in an electric drier, and then deposited in herbarium. Fungal tissues were mounted in 5% KOH for microscopic examination. Lengths and widths of 30 randomly selected spores were measured from spores deposited on a slide; 'av.' represents the average length and width values and 'Q' the mean length/width ratio. Light micrographs were taken using a Nikon Eclipse 80i trinocular phase contrast microscope and the scanning electron micrographs taken on a Philips FEI-XL30 scanning electron microscope. Colour designations within parentheses follow Kornerup & Wanscher (1978). The holotype is deposited in the Herbarium of Guangdong Institute of Microbiology (GDGM).

Genomic DNA was isolated from dried specimens and the ITS1-5.8S-ITS2 segment from the ribosomal DNA (rDNA) was amplified with primer sets ITS4 (5'-TCC TCC GCT TAT TGA TAT GC -3') and ITS5 (5'-GGA AGT AAA AGT CGT AAC AAG G-3') by polymerase chain reaction (PCR) techniques (White et al. 1990). Amplified products were examined with agarose gel electrophoresis using a 2kb DNA marker. The amplified PCR products were directly sequenced and deposited in GenBank.

Taxonomy

Volvariella nivea T.H. Li & Xiang L. Chen, sp. nov.

FIGS. 1-7

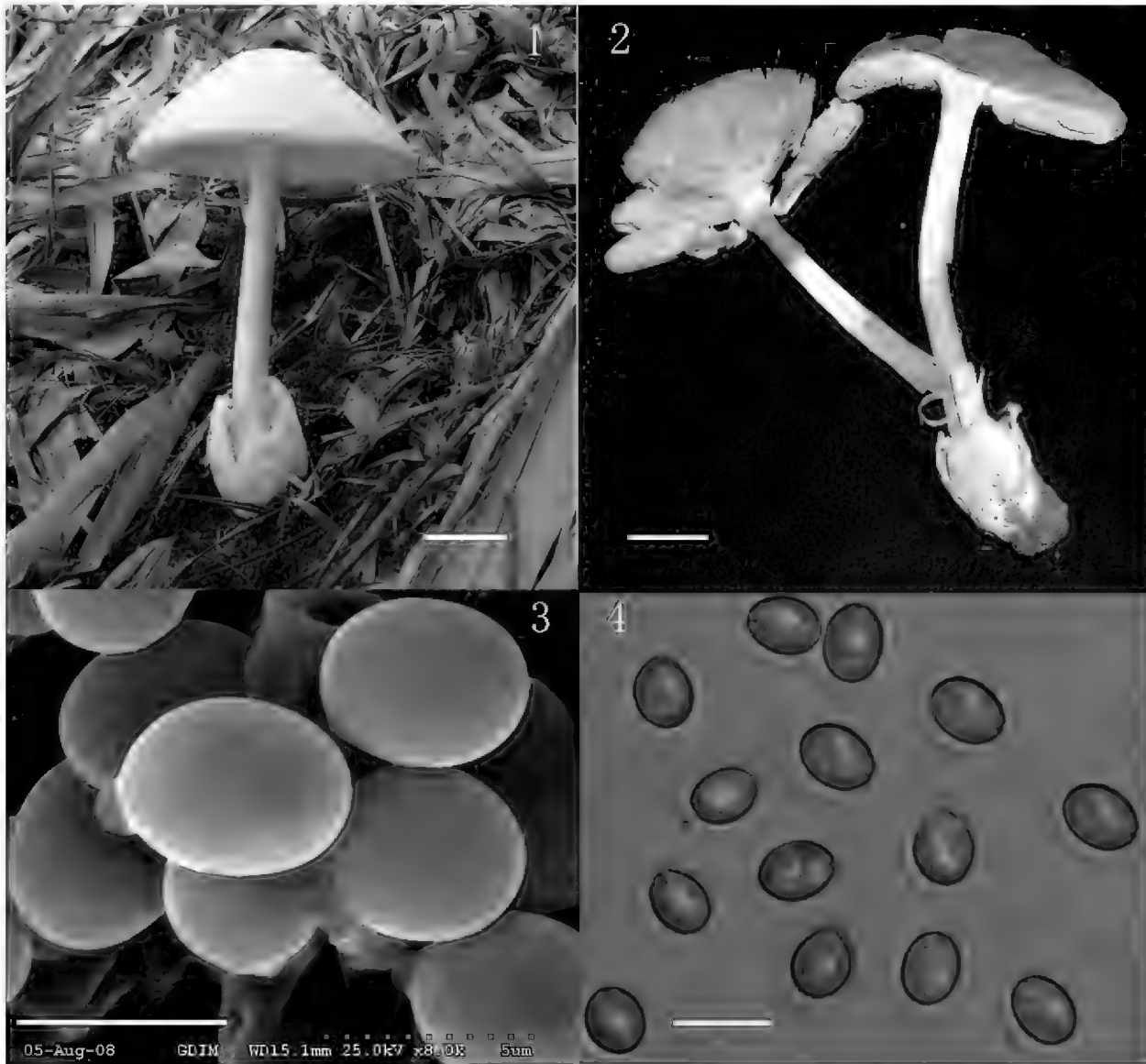
MYCOBANK MB 513096; GENBANK FJ749127

PILEUS 7–9 cm latus, campanulatus, conicus vel late convexus, albus, fibrillosus, sericeus, estriatus. *CONTEXTUS* albus, immutabilis, 5 mm crassus ad stipitem. *LAMELLAE* liberae, juvenili albidae, deinde incarnatae, ventricosae, 5–7 mm latae. confertae, lamellulis intermixtae. *STIPES* 10–11.5 × 0.7–0.8 cm., cylindricus, aequalis vel deorsum leviter incrassatus, pubescens vel villosus, deorsum glabrescens, albus. *VOLVA* alba, lobata, glabrous. *SAPOR* et *ODOR* mitis. *BASIDIOSPORAE* (5.2–)6.0–7.0(–8.0) × (4.0–)4.5–5.5 (–6.0) µm ovoideae vel late ellipsoideae, laeves, dilute roseae. *BASIDIA* 25–33 × 10–12.5 µm, clavata, hyalina, (2–)4-sporigera. *PLEUROCYSTIDIA* 60–132 × 19–44 µm, fusioidea vel ventricosa, raro ovoidea lanceoloidea vel subcylindrica. *CHEILOCYSTIDIA* similes ad pleurocystidia, 50–150 × 20–46 µm. *HYPHAE* defibulatae. Ad terram humosam in silvis.

HOLOTYPE: China, Guangdong Province, Guangzhou Municipality, Baiyun Mountain, 22 June 2008, T. H. Li & Xiang L. Chen GDGM 25489.

ETYMOLOGY: The epithet *nivea* refers to its snow white colour.

PILEUS 7–9 cm broad, fleshy, campanulate, conical to broadly convex, with a flattened disc, snow-white (10A1), fibrillose, not viscid; margin very thin, entire, non-striate, when mature with pinkish tint apparent from the pink lamellae beneath. *FLESH* thin, 5 mm thick near stipe, soft, white, unchanging when injured. *LAMELLAE* free, white (10A1) when young, becoming flesh-colour or pinkish to pink (10A2, 10A3), ventricose, moderately crowded, 8–9 per cm at pileus margin, 5–7 mm broad, with lamellulae; edge entire to slightly

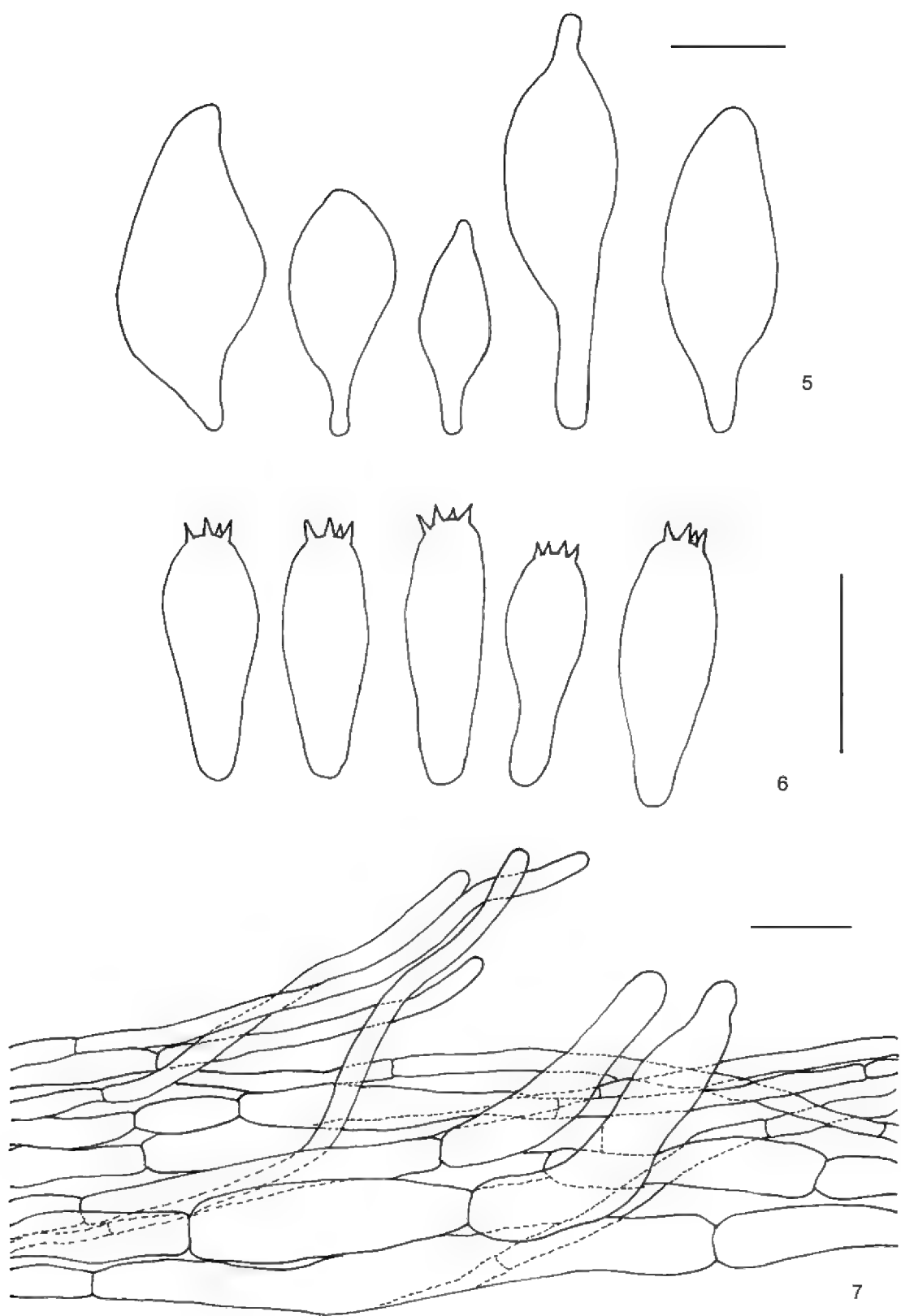


FIGS. 1–4: *Volvariella nivea* (GDGM25489). 1–2. Basidioma; 3–4. Basidiospores.

Bars: 1 = 20 mm; 2 = 20 mm; 3 = 5 μ m; 4 = 10 μ m

serrulate or pruinose. STIPE 10–11.5 \times 0.7–0.8 cm., central, cylindrical, equal to slightly enlarged downwards, pubescent to weakly fibrillose, slightly silky striate, both surfaces pure white. VOLVA free from the stipe, ample, fleshy, pure white, lobed. TASTE and ODOUR mild.

BASIDIOSPORES (5.2–)6.0–7.0(–8.0) \times (4.0–)4.5–5.5(–6.0) μ m (av.=6.5 \times 5.0), Q=(1.10–)1.15–1.41(–1.50) (av.=1.28), ovoid to broadly ellipsoid, smooth, with a stramineous or salmon-coloured, thickened wall. BASIDIA (2–)4 spored, 25–33 \times 10–12.5 μ m, clavate, hyaline; sterigmata 1–2 μ m long. PLEUROCYSTIDIA 60–132 \times 19–44 μ m, clavate, fusoid to fusoid-ventricose, sometimes ovoid or obovoid, usually constricted at base, with an acute or obtuse apex, sometimes with an elongate neck, thin-walled, hyaline. CHEILOCYSTIDIA 50–150 \times 20–46 μ m, similar to pleurocystidia. LAMELLA TRAMA inversely bilateral, with hyphae 6–20 μ m broad, thin-walled, hyaline. PILEUS TRAMA with hyphae 9–35 μ m



FIGS. 5–7: *Volvariella nivea* (GDGM25489). 5. Pleurocystidia and cheilocystidia; 6. Basidia; 7. Pileipellis.
Bars: 5 = 40 μm ; 6 = 20 μm ; 7 = 25 μm

broad, thin-walled, hyaline. PILEIPELLIS non-gelatinous, with hyphae 7–22 μm broad, colourless. VOLVAL REMNANTS made up of filamentous hyphae, with cells $32\text{--}56 \times 7.5\text{--}15 \mu\text{m}$ inside, and with more inflated cells $28\text{--}54 \times 14.7\text{--}24.5 \mu\text{m}$

at the both outer and inner surfaces, colourless. CLAMP CONNECTIONS absent in all tissues.

HABIT, HABITAT, DISTRIBUTION AND SEASON—Solitary on humus and debris under bamboo mixed with other broadleaf trees; China (Guangzhou). June.

COMMENTS— Another specimen (GDGM 26364), collected on 18 June 2009 from the type locality with a 12.5 cm broad pileus and 16×1.0 cm diam stipe, was a slightly larger than the type. The remaining characters are otherwise identical to the type.

Volvariella nivea is characterized by its terrestrial habit, pure white basidiomata, a fibrillose pileus, and relatively small basidiospores that are smaller than those of most white *Volvariella* species. The new species is classified in stirps *Bombycina* according to Singer (1986) based on its conspicuous fibrils and small spores.

Volvariella bombycina (Schaeff.) Singer is similar to *V. nivea* in having a white fibrillose pileus, but has longer pileal fibrils, longer and narrower basidiospores ($7.3\text{--}9.4 \times 4.8\text{--}5.7$ μm), and usually lignicolous habit (Fries 1821, Shaffer 1957). The substratum is of taxonomic importance in the genus *Volvariella* (Orton 1974). A variety named as *V. bombycina* var. *microspora* Dennis has similar spore size to that of the new species, but the pileus of the variety is lemon yellow and the basidiospores are narrower ($6\text{--}7.5 \times 4\text{--}5$ μm) (Dennis 1961).

Among the other white and medium to large-sized species with basidiospores less than 10 μm long, similar species can be distinguished from *V. nivea* with the following differences: *V. hypopithys* (Fr.) M.M. Moser has a smaller basidiomes with a 2–5 cm broad pileus, thinner membranous volva, and pileus fibrils often squamulose and extending beyond the pileal margin (Shaffer 1957). *Volvariella striata* N.C. Pathak has a pileus with a central umbo and obviously striate margin and slightly longer and narrower ($7.0\text{--}8.5 \times 4.2\text{--}5.7$ μm) basidiospores (Pathak 1975). *Volvariella castanea* (Masse) G.C. Rath has a glabrous, viscid pileus, and larger ($8\text{--}10 \times 8$ μm) basidiospores (Rath 1963). Finally, *V. diplasia* (Berk. & Broome) Singer has a coloured volva, longer ($7.5\text{--}10 \times 4.7\text{--}6.5$ μm) basidiospores, and a lignicolous habit (Saccardo 1887, Pegler 1986).

Volvariella speciosa (Fr.) Singer and *V. acystidiata* N.C. Pathak are also macroscopically similar to the new species, but they have much larger basidiospores. In *V. speciosa* the basidiospores are $(11.7\text{--})13.4\text{--}18.1(20.9) \times (7.2\text{--})8.3\text{--}10.3(12.4)$ μm and the pileus is viscid (Shaffer 1957) while in *V. acystidiata* the basidiospores are $13\text{--}14.5 \times 7.8\text{--}8.3$ μm (Pathak 1975). The similar *V. reidii* Heinem. has much smaller ($3.75\text{--}4.2 \times 2.2\text{--}3.2$ μm) basidiospores (Reid et al. 1977, Heinemann 1978).

The rDNA-ITS (ITS1-5.8S-ITS2 segment) sequence with 801 bps of the new species (FJ749127) differs from all other known *Volvariella* sequences. Through

a Blast search against the GenBank DNA database, only 171 bps of 5.8S of the sequence can be compared with 309 max scores and 98% maximal percent identities to those of *V. bombycina* (EU920673, EF566874), and with 303 max scores and 98% maximal percent identities to those of *V. volvacea* (FJ379274, FJ379273, FJ379272, AY636051, AY636050, AY636049). The remaining parts (ITS1 and ITS2, occupying about 79% of the whole segment) of the sequence are so different that they are not comparable with the known sequences. Therefore, *V. nivea* is considered distinct.

Acknowledgements

The authors are very grateful to Dr. Roy Watling of Caledonian Mycological Enterprises and Dr. Zhu L. Yang of Kunming Institute of Botany, Chinese Academy of Sciences for reviewing of the manuscript. The study was supported by the National Natural Science Foundation of China (No. 30770004) and the Natural Science Foundation of Guangdong (Nos. A06020222 and E05202480). Thanks are also to Dr. Dong-Mei Wang, Ms. Wang-Qiu Deng and Ms. Chun-Ying Deng who have participated in the study.

Literature cited

- Bi ZS, Zheng GY, Li TH. 1993. The Macrofungus Flora of China's Guangdong Province. The Chinese University Press: Hongkong. 348–355.
- Bi ZS, Li TH, Zhang WM, Song B. 1997. A Preliminary Agaric Flora of Hainan Province. Guangdong Higher Education Press: Guangzhou. 140–142. (in Chinese)
- Dennis RWG. 1961. Fungi Venezuelani: IV. Kew Bull. 15: 67–156.
- Fries EM. 1821. Systema Mycologicum I. Lundae. 277–278.
- He SC, Feng L. 1987. A new species of the genus *Volvariella* from Guizhou Province of China. Act. Myc. Sin. 6(3): 150–152. (in Chinese)
- Heineman P. 1978. Notulae. Bull. Jard. Bot. Nat. Belg. 48: 239.
- Huang NL. 1998. Colored Illustrations of Macrofungi (Mushrooms) of China. China Agricultural Press: Beijing. 452–457. (in Chinese)
- Kornerup A, Wanscher JH. 1978. Methuen Handbook of Colour. Eyre Methuen: London. 1–252.
- MEXM [Mycological Expedition to Xiaowutai Mountains in Hebei Province]. 1997. Fungi of Xiaowutai Mountains in Hebei Province. The Series of the Scientific Expedition, SMLL, CAS, No.1. China Agricultural Press: Beijing, China. 95 pp. (in Chinese)
- Mao XL. 1997. A Preliminary Study on Macrofungi in Ningxia, China. Ningxia J. Agr. Forest. Sc. techn. 1997(5): 1–6. (in Chinese)
- Orton PD. 1974. The European species of *Volvariella* Spegazzini. Bull. Mens. Soc. Linn. Lyon 43: 313–326.
- Pathak NC. 1975. New species of *Volvariella* from central Africa. Bull. Jard. Bot. Nat. Belg. 45(1): 195–196.
- Pegler DN. 1986. Agaric Flora of Sri Lanka. Her Majesty's Stationery Office: London. 222–230.
- Rath GC. 1963. The genus *Volvariella* Speg. in Lucknow. J. Indian Bot. Soc. 41(4): 524–530.
- Reid DA, Murton RK, Westwood NJ. 1977. Two new Agarics from Britain. Trans. Brit. Mycol. Soc. 68(3): 327–328.
- Saccardo PA. 1887. Sylloge Fungorum. Vol. V. Padova. 374 pp.

- Shaffer RL. 1957. *Volvariella* in North America. *Mycologia* 49: 545–579.
- Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4thed. Koeltz Scientific Books: Koenigstein. 1–981.
- Spegazzini C. 1899. Fungi argentini novi vel critici. *Anal. Mus. Nac. Buenos Aires* 6: 81–365.
- Tai FL. 1979. *Sylloge Fungorum Sinicorum*. Science Press: Beijing. 811 pp. (in Chinese)
- Teng SC. 1963. Fungi of China. Science Press: Beijing. 602–608. (in Chinese)

Three new species of *Monodictys* from soil

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Abstract — Three new species of *Monodictys* from soil in Tibet, China — *M. tuberculata*, *M. clavata* and *M. shigatsensis* — are described and illustrated. The type specimens (dried cultures) and living cultures are deposited in the Herbarium of Shandong Agricultural University Plant Pathology (HSAUP). The isotypes are kept in Herbarium of Institute of Microbiology, Academia Sinica (HMAS).

Key words — taxonomy, soil fungi, dematiaceous hyphomycetes

Introduction

Since the genus *Monodictys* S. Hughes was erected in 1958, more than 50 species have been recognized worldwide (indexfungorum.org/Names/Names.asp). In China 16 species have been recorded (Zhao & Zhang 2004, 2007; Liu & Zhang 2007). The conidium morphology (solitary, dictyospores, frequently subglobose, pyriform or clavate, often constricted at the septa, verrucose or smooth) can often be used to diagnose the genus. In the course of a survey of soil dematiaceous hyphomycetes in Tibet, three new species were found that match *Monodictys* morphologically but differ from all described species in the genus. They are described below.

Taxonomic descriptions

Monodictys tuberculata Y.M. Wu & T.Y. Zhang, sp. nov.

FIGURE 1

MYCOBANK MB 512985

Coloniae in PCA effusae, pallide brunneae. Mycelium partim superficiale et partim immersum. Hyphis hyalinis vel pallide brunneis, levibus vel verrucosis, 1–2 µm crassis compositum. Conidiophora micronemata, pallide brunnea, tuberculata, 8–50 µm longa, 4–8 µm crassa. Cellulae conidiogenae monoblasticae, determinatae, terminales, aliquando inflatae, 5–8 µm longae et 4–8 µm latae, hyalinae vel pallide brunneae. Conidia singularia,

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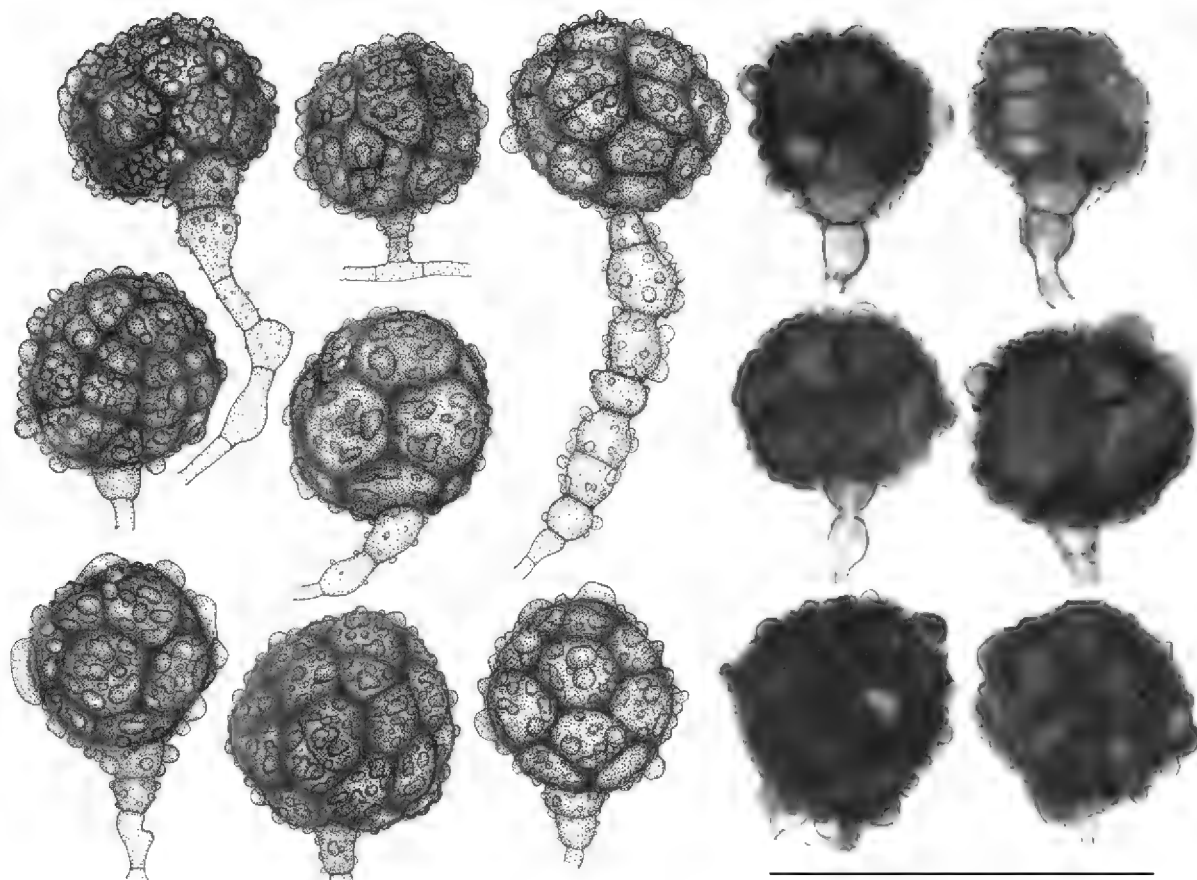


FIG. 1 Conidia and conidiogenous cells of *Monodictys tuberculata* (ex holotype; bar = 50 µm).
Left: drawings; right: photomicrographs

tuberculata, subglobose, ex cellulis globosis numerosis crasse tunicatis composita, brunnea vel atrobrunnea, 20–32 µm diam.

HOLOTYPE: isolated from grassland soil in Sannan, Tibet, China, altitude 3100 m, 14 Jun. 2007, Y.M. Wu, HSAUPII₀₇ 0834, holotype (HMAS 196213, isotype).

ETYMOLOGY: in reference to the tuberculate conidia.

Colonies effuse, pale brown to moderately brown, 50–60 mm diameter on PCA (potato carrot agar) at 25°C in 2 weeks. Mycelium partly superficial, partly immersed. Hyphae subhyaline to pale brown, smooth or verrucose, septate, 1–2 µm thick. Conidiophores solitary, tuberculate, straight or flexuous, pale brown, 8–50 µm long, 4–8 µm thick. Conidiogenous cells monoblastic, determinate, hyaline or pale brown, sometimes inflated, 5–8 µm long, 4–8 µm thick. Conidia solitary, terminal, globose to subglobose, tuberculate, brown to dark brown, often constricted at septa, 20–32 µm in diameter.

This species is somewhat similar to *Monodictys fluctuata* (Tandon & Bilgrami) M.B. Ellis (Ellis 1971) and *M. putredinis* (Wallr.) S. Hughes (Hughes 1958) in conidium morphology and size. The main distinction among these three taxa is that the conidium surface is obviously tuberculate in *M. tuberculata*, smooth in *M. putredinis*, and verrucose (with a larger, up to 40 µm, conidium) in *M. fluctuata*.

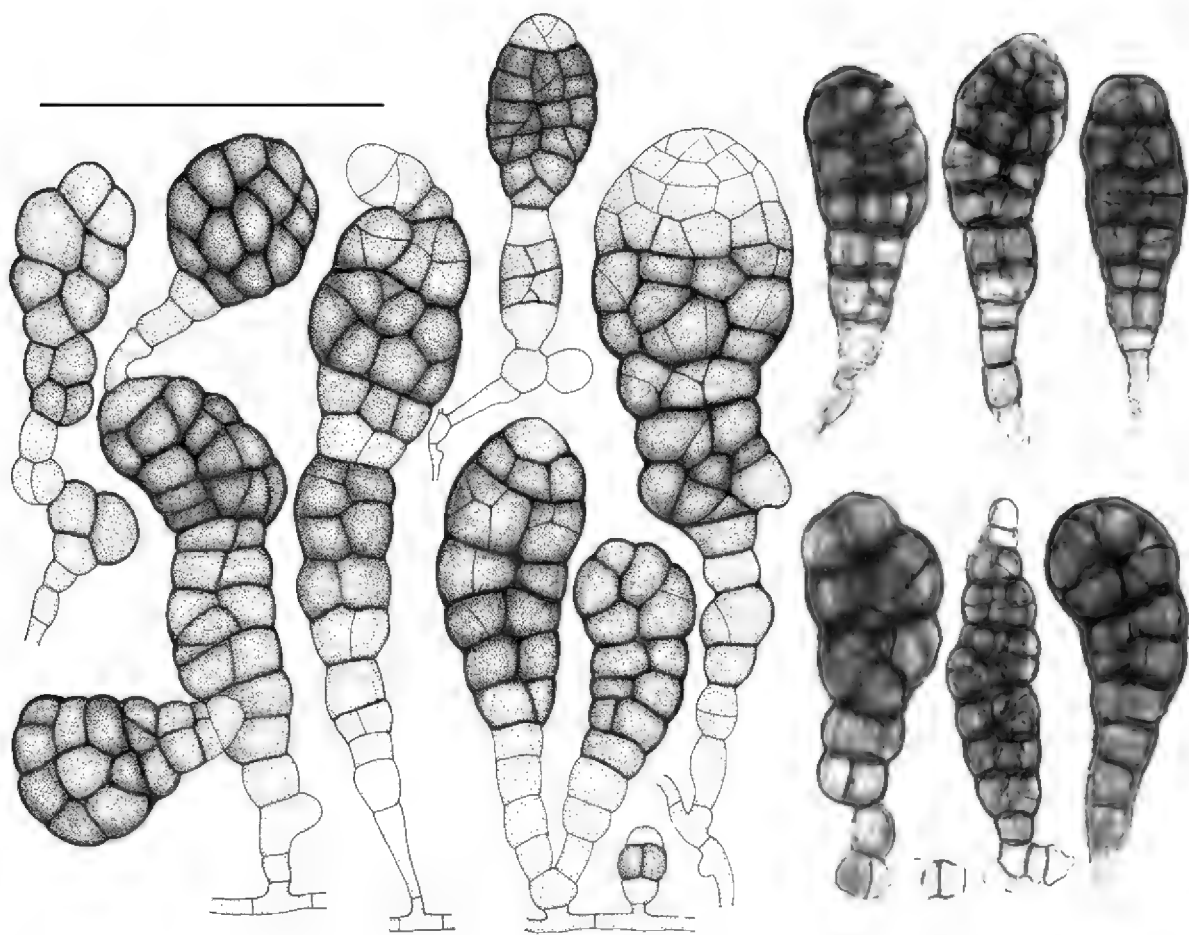


FIG. 2 Conidia and conidiogenous cells of *Monodictys clavata* (ex holotype; bar = 50 μm).
Left: drawings; right: photomicrographs

***Monodictys clavata* Y.M. Wu & T.Y. Zhang, sp. nov.**

FIGURE 2

MYCOBANK MB 512986

Coloniae in PCA effusae, brunneae. Mycelium partim superficiale et partim immersum, ex hyphis septatis, subhyalinis vel pallide brunnis, 1–2 μm crassis. Conidiophora singularia, laevia, recta vel curvata, pallide brunnea, 5–15 μm longa, 3–5 μm crassa. Cellulae conidiogenae 5–10 μm longae, 4–7 μm latae, hyalinae vel pallide brunneae. Conidia singularia, laevia, clavata vel pyriformia, plerumque constricta ad septa, pallide brunnea vel brunnea, 30–65 \times 12.5–32 μm .

HOLOTYPE: from grassland soil in Sannan, Tibet, China, altitude 3300 m, 11 Jun. 2007, Y.M. Wu, HSAUPII070659, **holotype** (HMAS 196214, isotype).

ETYMOLOGY: in reference to the clavate or pyriform conidia.

Colonies effuse, brown, 50–60 mm diameter on PCA at 25°C in 2 weeks. Mycelium partly superficial, partly immersed. Hyphae subhyaline to pale brown, 1–2 μm thick. Conidiophores solitary, smooth, straight or flexuous, pale brown, 5–15 μm long, 3–5 μm thick. Conidiogenous cells monoblastic, determinate, hyaline or pale brown, sometimes inflated, 5–10 μm long, 4–7 μm thick. Conidia frequently solitary, smooth, clavate or pyriform, pale brown to brown, often constricted at the septa, 30–65 \times 12.5–32 μm .

This fungus somewhat resembles *Monodictys lepraria* (Berk.) M.B. Ellis (Ellis 1976) and *M. paradoxa* (Corda) S. Hughes (Hughes 1958) in conidium morphology. However, *M. paradoxa* conidia are mainly oval and shorter ($20\text{--}43 \times 17\text{--}30\text{ }\mu\text{m}$), and *M. lepraria* conidia are larger (up to $100 \times 50\text{ }\mu\text{m}$) than those in *M. clavata*.

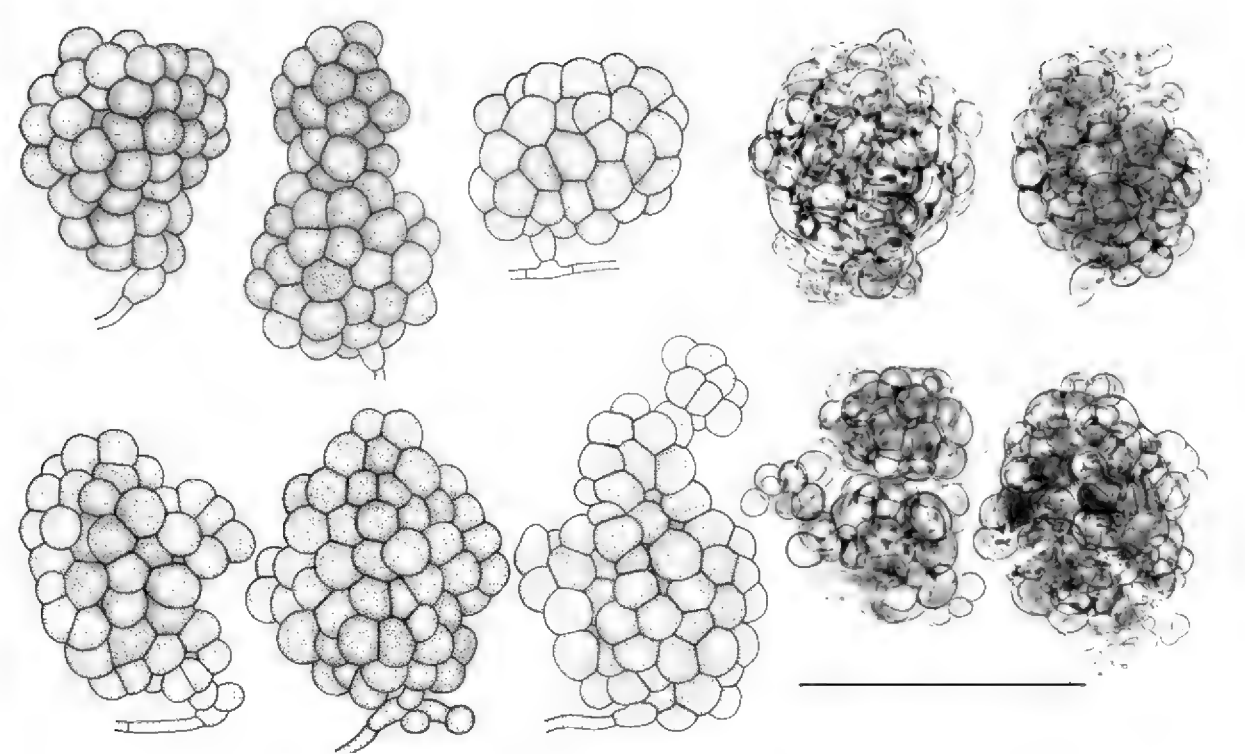


FIG. 3 Conidia and conidiogenous cells of *Monodictys shigatsensis* (ex holotype; bar = 50 μm).
Left: drawings; right: photomicrographs

***Monodictys shigatsensis* Y.M. Wu & T.Y. Zhang, sp. nov.**

FIGURE 3

MYCOBANK MB 512987

Coloniae in PCA vel effusae, pallide brunnea. Mycelium partim superficiale et partim immersum, ex hyphis subhyalinis vel pallide brunnis, 1–2 μm crassis. Conidiophora singularia, laevia, recta vel curvata, pallide brunnea, 5–15 μm longa, 3–5 μm crassa. Cellulae conidiogenae 5–10 μm longae et 2–4 μm latae, hyalinae vel pallide brunneae. Conidia singularia, laevia, obovoidea, pyriformia vel irregulariter muriformia, pallide brunnea, plerumque constricta ad septa, $40\text{--}65 \times 30\text{--}45\text{ }\mu\text{m}$.

HOLOTYPE: from grassland soil in Shigatse, Tibet, China, altitude 3000 m, 9 Sep. 2007, Y.M. Wu, HSAUPII₀₇ 0889, holotype (HMAS 196215, isotype).

ETYMOLOGY: in reference to the type location.

Colonies effuse, pale brown, 50–60 mm diameter on PCA at 25°C in 2 weeks. Mycelium partly superficial, partly immersed. Hyphae subhyaline to pale brown, 1–2 μm thick. Conidiophores solitary, smooth, straight or flexuous, pale brown, 5–15 μm long, 3–5 μm thick. Conidiogenous cells 5–10 μm long, 2–4 μm thick, hyaline or pale brown. Conidia solitary, smooth, obovoid, pyriform or irregularly muriform, pale brown, often constricted at the septa, $40\text{--}65 \times 30\text{--}45\text{ }\mu\text{m}$.

The most closely related species in conidium morphology are *Monodictys chlamydosporoidea* H.M. Liu & T.Y. Zhang (Liu & Zhang 2007) and *M. gemmipara* Vasant Rao & de Hoog (Rao & Hoog 1995). However, the conidia of *M. chlamydosporoidea* are smaller ($23\text{--}44 \times 17\text{--}30\text{ }\mu\text{m}$) and composed of fewer cells. *M. gemmipara* differs in dark reddish brown, larger ($50\text{--}70 \times 45\text{--}50\text{ }\mu\text{m}$) conidia.

Acknowledgments

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Literature cited

- Ellis MB. 1971. Dematiaceous Hyphomycetes. CMI, Kew, Surrey, England: 1–608.
- Ellis MB. 1971. Dematiaceous Hyphomycetes. X. Mycol. Pap. 125: 1–30.
- Ellis MB. 1976. Dematiaceous Hyphomycetes. CMI, Kew, Surrey, England: 1–507.
- Hughes SJ. 1958. Revisiones hyphomycetum aliquot cum appendice de nominibus rejiciendis. Can. J. Bot. 36: 727–836.
- Liu HM, Zhang TY. 2007. The species of *Monodictys* (Hyphomycetes) from soil in warm temperate zone of east China. Mycosystema 26: 336–338.
- Matsushima T. 1975. Icones Microfungorum A Matsushima Lectorum, Kobe, 1–209 + plates.
- Matsushima T. 1985. Matsushima Mycological Memoirs No.4.
- Matsushima T. 1993. Matsushima Mycological Memoirs No.7.
- Rao VG, Hoog GS. de. 1986. New or critical Hyphomycetes from India. Stud. Mycol. 28: 28.
- Zhao GZ, Zhang TY. 2004. Notes on dictyosporic hyphomycetes from China V. The genus *Monodictys*. Mycosystema 23: 324–327.
- Zhao GZ, Zhang TY. 2007. Species of the genus *Monodictys* (Hyphomycetes) from China Mycosystema 26: 324–335.

***Elaphomyces citrinus* and *Elaphomyces maculatus* in Sicily (southern Italy)**

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Abstract — The first record of *Elaphomyces maculatus* from Sicily is reported. The presence of *E. citrinus* in Sicily, first indicated a century ago by Mattiolo in his monograph on hypogeous fungi of Sardinia and Sicily, is confirmed. Notes on the taxonomy, ecology and distribution of these two infrequent hypogeous fungi are provided.

Key words — macromycetes, Mediterranean area

Introduction

From the beginning of 2000, a research team with dogs trained to find hypogeous fungi has been working in Sicily. The result of this group's activities has been an increase in the number of fungi recorded from the island and a wider knowledge of the ecology and distribution of hypogeous fungi. Searches in several forest ecosystems revealed the presence of two interesting *Elaphomyces* species. As a contribution to knowledge of hypogeous fungi, the ecology and distribution of *E. citrinus* and *E. maculatus* are discussed in this paper.

Materials and methods

Between February 2006 and December 2007, several forest ecosystems at different altitudes were investigated in Sicily, with the help of dogs trained in detection of hypogeous fungi. Specimens were identified while fresh, and microscopic features were observed in an aqueous solution using a Leica microscope DMLB. The scientific binomials of recorded taxa were checked with Index Fungorum (<http://www.indexfungorum.org/Names/Names.asp>). Macroscopic and microscopic features such as the structure of ascomata, peridium, gleba, asci, and spores, were noted. The cartographic references, habitats, and altitudinal range of each taxon were listed. Distributional

information was referred to the 1:50,000 scale edition of the Official Map of the Italian State (I.G.M.I.), following methodology proposed by Padovan (1994). Specimens have been deposited in the Herbarium Mediterraneum (PAL).

Taxonomic arrangement and data recorded

Elaphomyces Nees (*Elaphomycetaceae*) is a widespread genus including twenty ectomycorrhizal hypogeous fungi (Kirk & al. 2008).

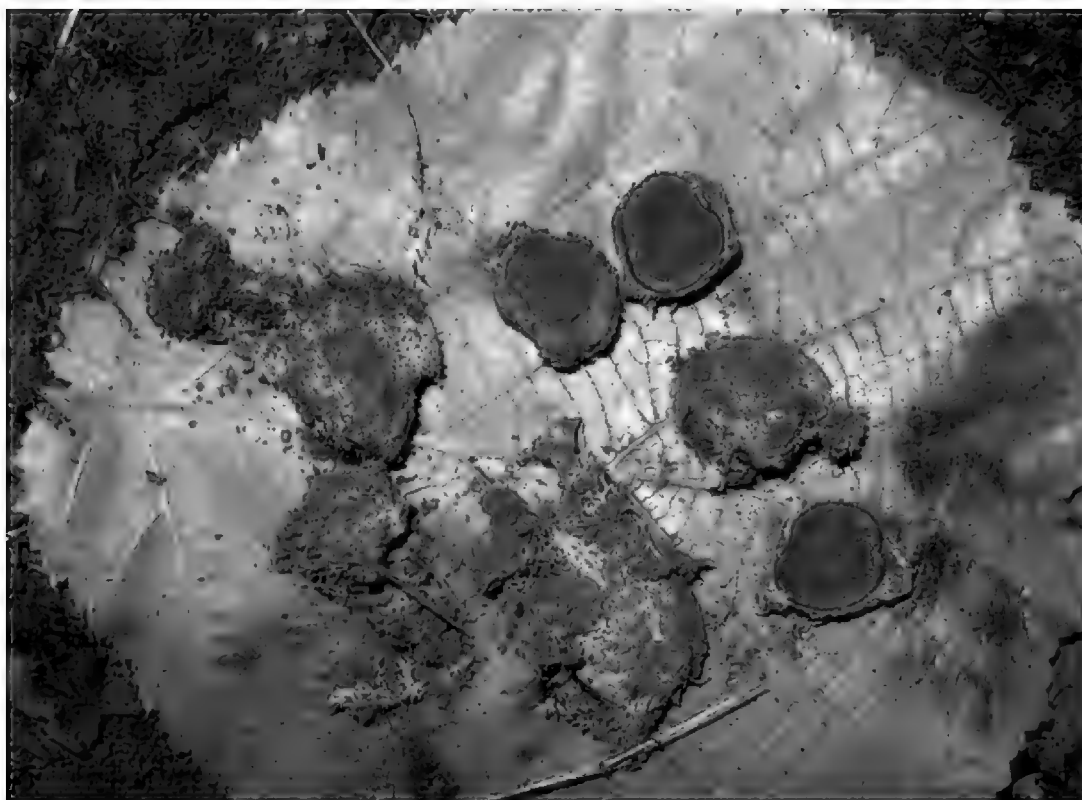
Trappe (1979) proposed a new order *Elaphomycetales* based on *Elaphomyces*, but Kirk & al. (2008) include the genus within the order *Eurotiales*. The species are characterized by hypogeous pulverothecia, mycorrhizal mycelium, and asci developed inside a hollow structure (Weber & al. 1997).

The morphological and microscopic characters of the two species recorded in Sicily are reported below together with the localities of collection and some ecological and distributional notes.

Elaphomyces citrinus Vittad.

FIG. 1

Ascomata hypogeous, subglobose, 1–3 cm in diameter, usually covered with an evident, adherent and hard to separate, lemon-yellow mycelium, binding soil particles to form a crust. Cortex thin, ca. 50–80 μm thick, composed of dark brown hyphae, which are heavily carbonised. Peridium rather thick, 1–2 mm with a thinner black carbon-like outer cortex and a dark grey layer below, with a tissue of filamentous hyphae. The mycelium surface is lemon yellow,



Ascomata of *Elaphomyces citrinus* collected in hazel agro-ecosystems.

comprising thin-walled, branched and often anastomosing hyphae, 2.5–4 μm diam. The ripe gleba is composed of a grey-dark brown powder of thin walled hyphae. Asci globose, with 8 spores. Spores spherical, 11–12.5 μm in diameter excluding ornament, dark brown when ripe, lightly aculeate-roughish, ornamented with fine, dense, evenly distributed, rods or spines 0.5–1 μm high. Odour intense, *Tuber*-like.

LOCALITIES: Mezz'Agosto, Sant'Angelo di Brolo (province of Messina), 260 m, 599132, 1 Dec 2006, *Corylus avellana* L. cultivation; Castell'Umberto (province of Messina), Ecological Park, 660 m, 599311, 2 Dec 2006, wood of *Quercus ilex* L.; wood of *Q. pubescens* Willd. s.l.,

Elaphomyces maculatus Vittad.

FIG. 2

Ascomata hypogeous, subglobose to tuberiform, 4×2.5 cm, bound with a crust of soil, particles and mycelial hyphae, greenish then brown-blackish; surface of peridium smooth or very finely papillate under the lens, glossy, brown-black, often with persistent greenish spots. Peridium consisting of an outer brown-black cortex, and of an inner fleshy layer, 1.5 mm thick, whitish then grey, finally brown-black, and becoming very thin. The ripe gleba consists of a powdery mass of spores and thin-walled, olive-grey hyphae. Asci globose with 8 spores. Spores spherical, coloured, olive to blackish, 34–38 μm . Odour of sour bread or mustard.

LOCALITY: Bosco di Malabotta, Montalbano Elicona (province of Messina), 1250 m, 613442, 22 Feb 2006, mixed wood of *Quercus cerris* L., *Castanea sativa* Mill., *Fagus sylvatica* L.



Ascomata of *Elaphomyces maculatus* collected in oak woods mixed with chestnut and beech.

Discussion

In Europe, *Elaphomyces citrinus* is reported from the British Isles (Cannon & al. 1985, Pegler & al. 1993, Ramsbottom & al. 1951) and from Spain (Vidal 1997). *Elaphomyces citrinus* is also included, as a “non protected” species, in the Inventaire National du Patrimoine Naturel (INPN). Pegler & al. (1993) pointed out that *E. citrinus* “has been rarely recorded so that its true distribution and ecology remain uncertain”. The first references to the presence of *Elaphomyces citrinus* and *E. maculatus*, in oak woods of northern Italy, were provided by Saccardo (1889). *Elaphomyces citrinus* has been rarely described or illustrated and the previous collections from Italy were limited to the provinces of Milano and Pavia (Vittadini 1831). Mattiolo (1900) published an interesting monograph on hypogeous fungi of Sardinia and Sicily, which included *Elaphomyces* species. The fungi reported were collected for the most part by local people, who helped Mattiolo in his survey. In particular Mr. Fanfani sent Mattiolo a sample of *E. citrinus* collected on April 3rd, 1900 from a chestnut wood in the neighbourhood of the convent of Gibilmanna (Cefalù, province of Palermo). The new find reported in the present work extends the area of distribution of *E. citrinus* to northeastern Sicily and introduces some new aspects to the ecology of this interesting fungus, for example the presence of the species in agro-ecosystems such as cultivated hazel. It also contributes to a better definition of the altitudinal range of *E. citrinus* in Italy, which is currently from 260 to 1250 m, i.e. from the Mediterranean to the Subatlantic vegetational belt (sensu Pignatti 1979).

Elaphomyces maculatus is considered as an infrequent species in Europe and is included in several red-lists. According to IUCN criteria *E. maculatus* was reported as VU in Sweden (<http://www.artdata.slu.se/english/redlist.asp>) and as V (Exposed) in the Red List of Plants and Fungi of Poland (Wojewoda & Ławrynowicz 2006). *Elaphomyces maculatus* was also included in the Rote Liste Grosspilze of Germany (<http://www.pilzbestimmer.de/texte/rote-liste-pilze-de.html>) and the Databases at the Department of Cryptogamic Botany-The Swedish Museum of Natural History (www.nrm.se). *Elaphomyces maculatus* was, furthermore, recorded from Sweden by Kers (1978) and recently from Hungary (Siller 2005) and Spain (Vidal & al. 1997). In addition to the report by Saccardo (1889), the other most recent record of *E. maculatus* in Italy is from Tuscany (Gori 2005). The authors reported the presence of *E. maculatus* in November, “in a wood” of the province of Lucca (Tuscany), located at 800 m, while Montecchi & Sarasini (2000) reported other localities from the provinces of Parma and Reggio Emilia (Emilia Romagna) and the surroundings of Vicenza (Veneto) in woods of *Fagus sylvatica*, “sometimes mixed with other broad-leaved plants, from summer to the late autumn, at altitudes not higher than 1400 m.” The same authors also pointed out some records of *E. maculatus*

on charcoal. The presence of *E. maculatus* in the “subatlantic belt”, characterized by beech woods, and the altitudinal range not exceeding 1400 m is confirmed also from Sicily. The fruiting period, usually reported as autumnal in northern Italy, is extended to late winter (February) in Sicily. In our opinion this different ecological datum is due, in some measure, to the different climatic conditions of the island and to the different type of vegetation, which is characterized by a mixed wood of *Quercus cerris*, *Castanea sativa*, and *Fagus sylvatica*.

Finally the size of ascomata and spores of *E. citrinus* and *E. maculatus* collected in Sicily are usually bigger than the measurements reported by Montecchi & Sarasini (2000).

Acknowledgements

The authors wish to thank Dr David Minter (United Kingdom) and Dr Mario Honrubia (Spain) for critically reviewing the manuscript.

Literature cited

- Cannon PF, Hawksworth DL, Sherwood-Pike MA. 1995. The British *Ascomycota*, an annotated check-list. UK, Kew, Commonwealth Mycological Institute & British Mycological Society.
- Gori L. 2005. Funghi ipogei della Lucchesia, di altre province italiane e dall'estero. Maria Pacini Fazi Editore, Lucca.
- Kers LE. 1978. *Elaphomyces maculatus* found in Sweden. Bot. Notiser 131: 419-422.
- Kirk PM, Cannon PE, Minter DW, Stalpers JA. 2008. Dictionary of the fungi. 10th Edition. CABI Europe, UK.
- Mattirolo O. 1900. Gli ipogei di Sardegna e Sicilia. Malpighia 14: 39-110.
- Montecchi A, Sarasini M. 2000. Funghi ipogei d'Europa. Associazione Micologica Bresadola, Fondazione Centro Studi Micologici Trento. 714 pp.
- Padovan F. 1994. Mappatura dei macromiceti in Italia (problemi cartografici). Rivista di Micologia 1: 59-69.
- Pegler DN, Spooner BM, Young TWK. 1993. British truffles. A revision of British hypogeous fungi. Royal Botanic Gardens, Kew.
- Pignatti S. 1979. I piani di vegetazione in Italia. Giornale Botanico Italiano 113: 411-428.
- Ramsbottom J, Balfour-Browne FL. 1951. List of discomycetes recorded from the British Isles. Transactions of the British Mycological Society 34(1): 38-137.
- Saccardo PA. 1889. Sylloge Fungorum, 8: 865-866. Patavii.
- Siller I, Vasas G, Pál-Fám F, Bratek Z, Zagyva I, Fodor L. 2005. Hungarian distribution of the legally protected macrofungi species. Studia Botanica Hungarica 36: 131-163.
- Trappe JM. 1979. The orders, families, and genera of hypogeous *Ascomycotina* (truffles and their relatives). Mycotaxon 9: 297-340.
- Vidal JM. 1997. Algunos hongos hipogeos nuevos o poco citados de cataluña (*Zygomycotina*, *Ascomycotina* y *Basidiomycotina*). Revista Catalana de Micologia 20: 25-62.
- Vidal JM, Vila J, García F, y Pérez-Jarauta T. 1997. Algunos hongos hipogeos de Castilla-León (España): *Youngiomyces multiplex* y *Genea thaxterii*, primeras citas para Europa. Revista Catalana de Micologia 20: 85-98.
- Vittadini C. 1831. Monografia Tuberaceum. Ex Typographia Felicis Rusconi, Mediolani.

- Weber NS, Trappe JM, Denison WC. 1997. Studies on western American *Pezizales*. Collecting and describing ascomata. Macroscopic features. Mycotaxon 61: 153-176.
- Wojewoda W, Ławrynowicz M. 2006. Red List of the macrofungi in Poland. In Mirek., Z., Zakrzycki K., Wojewoda W. & Szalag Z. (eds.). Red List of plants and fungi in Poland. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków, pp. 53-70.

Two setose anamorphic fungi: *Ampullicephala* gen. nov. and *Venustosynnema grandiae* sp. nov.

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Abstract — *Ampullicephala* gen. nov. is established to accommodate *Pleurotheciopsis setiformis*. *Venustosynnema grandiae* anam. sp. nov., found on a decaying stem of an unidentified dicotyledonous plant in “Serido”, Rio Grande do Norte, Brazil, is described and illustrated. This fungus is characterized by a determinate, polysetose, synnematal conidiomata with a central acuminate, verrucose, dark red-brown seta encircled by numerous marginal verrucose, acerose, red-brown setae. Notes and illustrations on *V. ciliatum* are also given.

Key words — tropical rainforest, systematics, conidial fungi

Introduction

Re-examination of material of *Pleurotheciopsis setiformis* (Castañeda 1985) showed that it has blastic-synchronous conidium ontogeny developing in terminal, integrated, ampulliform conidiogenous cells. This pattern of ontogeny was classified as conidial development type 9 (holoblastic, apical wall-building simultaneously at several loci per conidiogenous cell and conidia becoming conidiogenous to form connected unbranched chains, each conidium delimited by 1 septum, maturation by diffuse wall-building, secession schizolytic, no conidiogenous cell proliferation) in Kirk et al. (2008). It is clearly different from *Pleurotheciopsis pusilla* B. Sutton (Sutton 1973), type species of the genus, which has blastic-sympodial proliferations and several broad, flat, sloping scars (loci) on the surface of the conidiogenous cells after conidial secession; this pattern of ontogeny was classified as conidial development type 10 (holoblastic, regularly alternating with sympodial proliferation, maturation by diffuse wall-building and secession schizolytic) in Kirk et al. (2008). These remarkable differences provide good reason to regard *P. setiformis* as different at the generic level from *P. pusilla*, and therefore the new genus *Ampullicephala* is proposed.

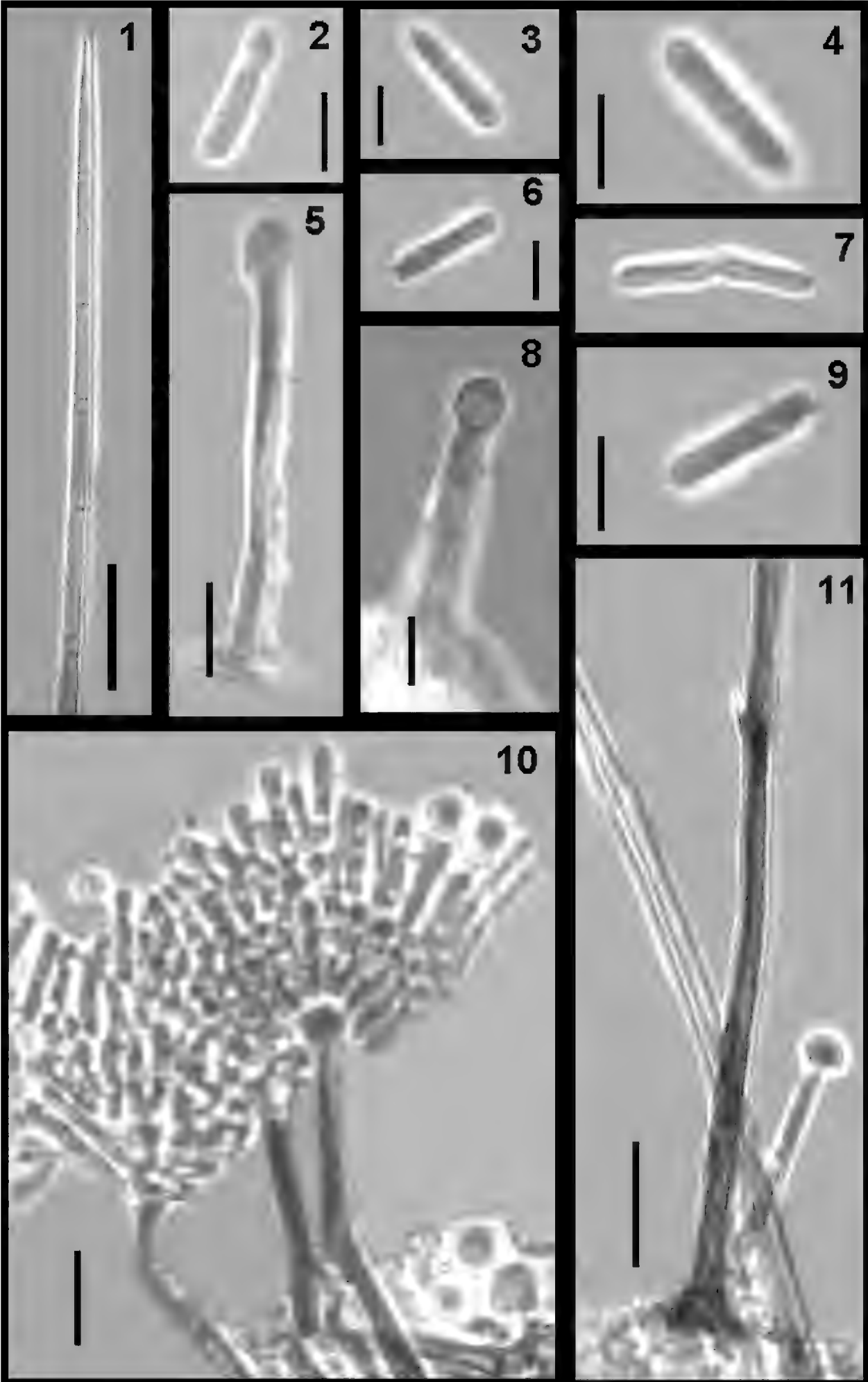
During an expedition in 2006 through the “Serido” caatinga vegetation, Rio Grande do Norte, Brazil, a conspicuous anamorphic fungus belonging to the genus *Venustosynnema* was collected. This appears to be conspecific with the fungus published as *V. ciliatum*, type species of the genus that Grandi & Gusmão (1996, 2002) examined from decaying roots of *Calathea zebrina* Lindl. and leaves of *Tibouchina pulchra* Cogn., but those authors mentioned the differences between the specimens examined and *V. ciliatum*. After comparing several specimens collected in Brazil with the type specimen of *V. ciliatum*, remarkable differences were found and therefore a new species for the Brazilian fungus is proposed.

Materials and methods

Samples of plant material were placed in separate paper bags and taken to the laboratory, then incubated in Petri dishes at 25° C in a moist chamber composed of plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol, and examined at regular intervals for the presence of microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol) and microscopic measurements made at a magnification of $\times 1000$.

FIGS. 1–11. *Ampullicephala setiformis*, photomicrographs from holotype (INIFAT C85/79). FIG. 1. Seta. FIGS. 2–4, 6–7, 9. Conidia. FIGS. 5, 8, 11. Conidiophores and conidiogenous cells. FIG. 10. Conidiophores and conidiogenous cells and conidia.

Scale is indicated by bars (FIGS. 1, 11: 40 μm ; FIGS. 2–4, 6–7, 9: 3 μm ; FIGS. 5, 8: 20 μm)



Taxonomy

Ampullicephala R.F. Castañeda, Minter & M. Stadler, **anam. gen. nov.**

MYCOBANK, MB 512123

Fungus anamorphicus pertinens. COLONIAE in substrato naturali pilosae usque ad caespitosa, effusae, albo-brunnea vel brunneae. Mycelium partim superficiale et partim in substrato. SETAE cylindricae, acerosae ad usque acuminatae, erectae, septatae, simplicissimae vel ramosae, leviae vel verrucosae, brunneae ad usque nigrae, contiguae ad conidiophorae oriundae. CONIDIOPHORA macronematosa, mononematosa, septata, brunnea vel olivacea, latvia vel verrucosa. CELLULAE CONIDIOGENAE polyblasticae, simultaneae, ampulliformes, terminales, determinatae cum minutis denticulis, non manifestis praeditae. CONIDIORUM SECESSIO schizolytica. CONIDIA blastico-simultanea, catenulata, cilíndrica vel oblonga, hyalina, 0–1-septata ad usque pluriseptata, laevia vel verrucosa. Teleomorphosis ignota.

TYPE SPECIES: *Ampullicephala setiformis* (R.F. Castañeda) R.F. Castañeda, Minter & M. Stadler

ETYMOLOGY: Latin, *ampullicephala*, referring to the head-shaped of the conidiogenous cells.

Anamorphic fungi. COLONIES on the natural substrate hairy to velvety, spreading, brown or white-brown. Mycelium superficial and immersed. SETAE cylindrical, acerose or acuminate, erect, septate, simple or branched, smooth or verrucose, brown to black, arising on the same hyphae near the conidiophores. CONIDIOPHORES macronematous, mononematous, septate, brown to olivaceous, smooth or verrucose. CONIDIOGENOUS CELLS polyblastic, synchronous, ampulliform, terminal, determinate, with small, inconspicuous denticles. CONIDIA blastic-synchronous, cylindrical or oblong, hyaline, 0–1-septate or pluriseptate, smooth or verrucose, produced in short acropetal chains. Teleomorph unknown.

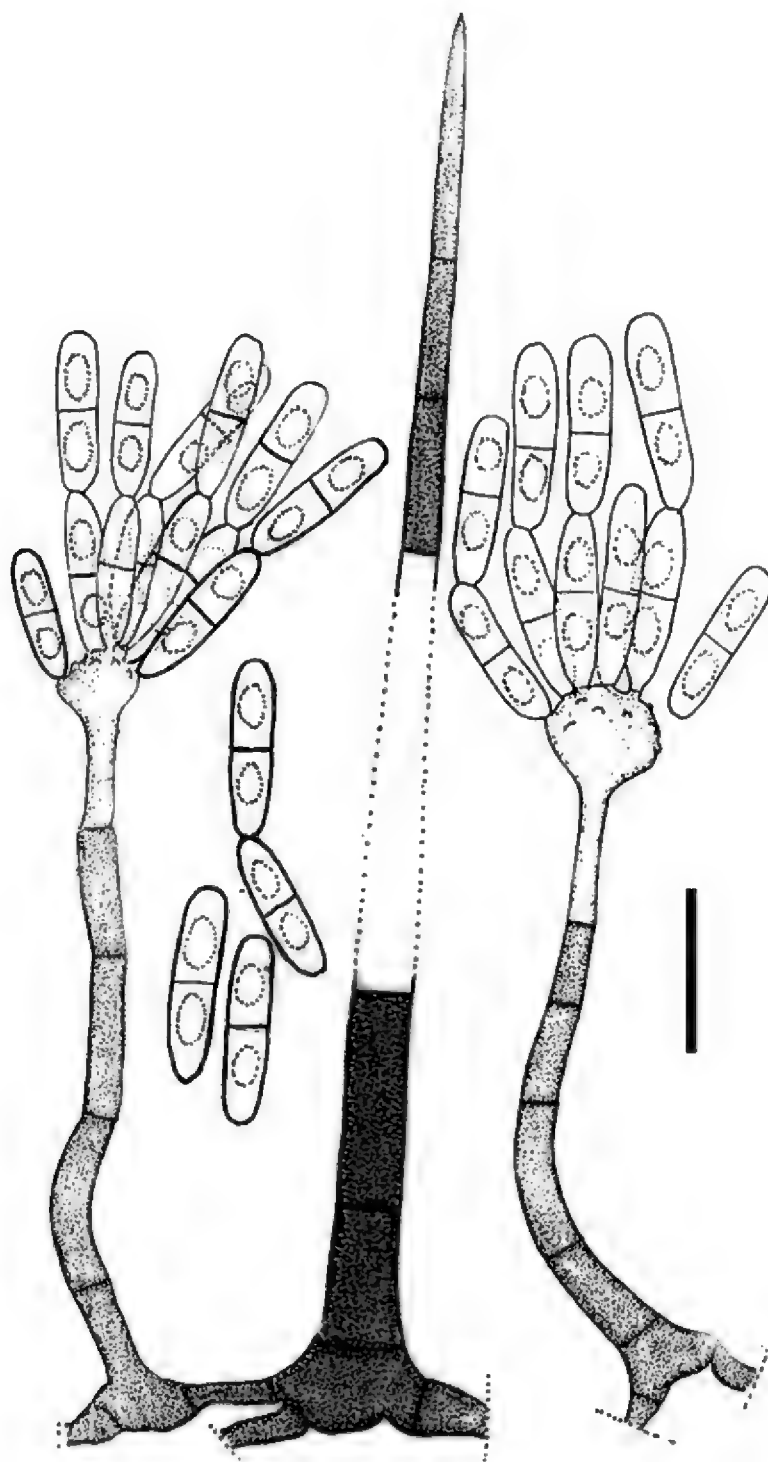
Ampullicephala setiformis (R.F. Castañeda) R.F. Castañeda, Minter & M. Stadler, **comb. nov.**

MYCOBANK MB 512124

FIGS. 1–12

BASIONYM: *Pleurotheciopsis setiformis* R.F. Castañeda,
Deuteromycotina de Cuba. Hyphomycetes III: 28 (1985).

COLONIES on the natural substrate hairy to caespitose, mostly epiphyllous, rarely amphigenous, white-brown. Mycelium superficial and immersed, composed of septate, branched, brown, 2.0–3.5 µm diam. hyphae. SETAE cylindrical, acerose, 4–12-septate, erect, straight, simple, smooth, brown below, pale brown towards the apex, 100–220 × 5–7 µm, near conidiophores arising from the same hyphae. CONIDIOPHORES macronematous, mononematous, capitate, 1–5-septate, erect, straight, simple, smooth, up to 110 µm tall and 3.5–6.0 µm wide at the base. CONIDIOGENOUS CELLS ampulliform, blastic-synchronous, terminal, determinate, 4–12 × 4–6 µm, very pale brown to



FIGS.12. *Ampullicephala setiformis*, drawings from holotype (INIFAT C85/79).
Seta, conidiophores, conidiogenous cells and conidia.
Scale is indicated by bar (10 μ m).

subhyaline, with 6–12 inconspicuous denticles. CONIDIA cylindrical to oblong, slightly truncated at the ends, 1-septate, guttulate, hyaline, 7–8(–12) \times 4–6 μ m, formed in short acropetal white chains. Conidia usually remain connected after they are released.

SPECIMEN EXAMINED: INIFAT C85/79 (holotype). CUBA, PINAR DEL RIO: SOROA, on decaying leaves of *Bauhinia cumanensis* Kunth, 22° 47' N and 83° 00' W, 240 m alt, 12.IV.1982, coll. R.F. Castañeda Ruiz.

COMMENTS: Da Cruz et al. (2007) provided a description and illustration of *Ampullicephala setiformis* (as *Pleurotheciopsis setiformis*) found on a decaying leaf of an unidentified plant in Brazil. In other genera of anamorphic fungi with synchronous conidial development, the proximal conidia are produced simultaneously on ampulliform conidiogenous cells; secondary and tertiary conidia do not develop at the same time as in *Gonatobotryum* Sacc. and *Gonatobotrys* Corda (Walker & Minter 1981). Somewhat similar conidial development can be observed in *Aureobasidium* Viala & G. Boyer, *Botryosporium* Corda, and *Botrytis* P. Micheli ex Pers., however no taxa have been reported with the combined characters of setae, conidiophores or hyphal conidiomata with synchronous conidium ontogeny, and hyaline, 0–1-septate, blastocatenulate conidia as are exhibited by *Ampullicephala*.

Venustosynnema grandiae Gusmão, V.O. Moraes & R.F. Castañeda, **anam. sp. nov.**

MYCOBANK MB 511073

FIGS. 13–31

Ad Venustosynnemis ciliati differt in conidiomatis synnematis atro rubro-brunneis, 350–450 × 17–25 µm (setis centralibus exclusis). SETIS centralibus, acuminatis, ad usque 630 µm alti, 8–12 µm crassis, verrucosis, atrobunneis, 20- ad 27-septatis et filamentis circundatis septatis, percompactis, dilute brunneis vel brunneis 2–3 µm, laevibus, sed deinde in setis marginalibus mutatis ad apicem. SETIS MARGINALIBUS verrucosis interdum tuberculatis ad basim, acuminata, atrobunneis vel rubro-brunneis, 125–260 × 6.0–7.5 µm. CONIDIA alantoidea, hyalina, laevia, 6–8(–10) × 1.5–2.0 µm, utrimque setulosa, setula 4–6 µm longa in massa mucosa, alba congesta.

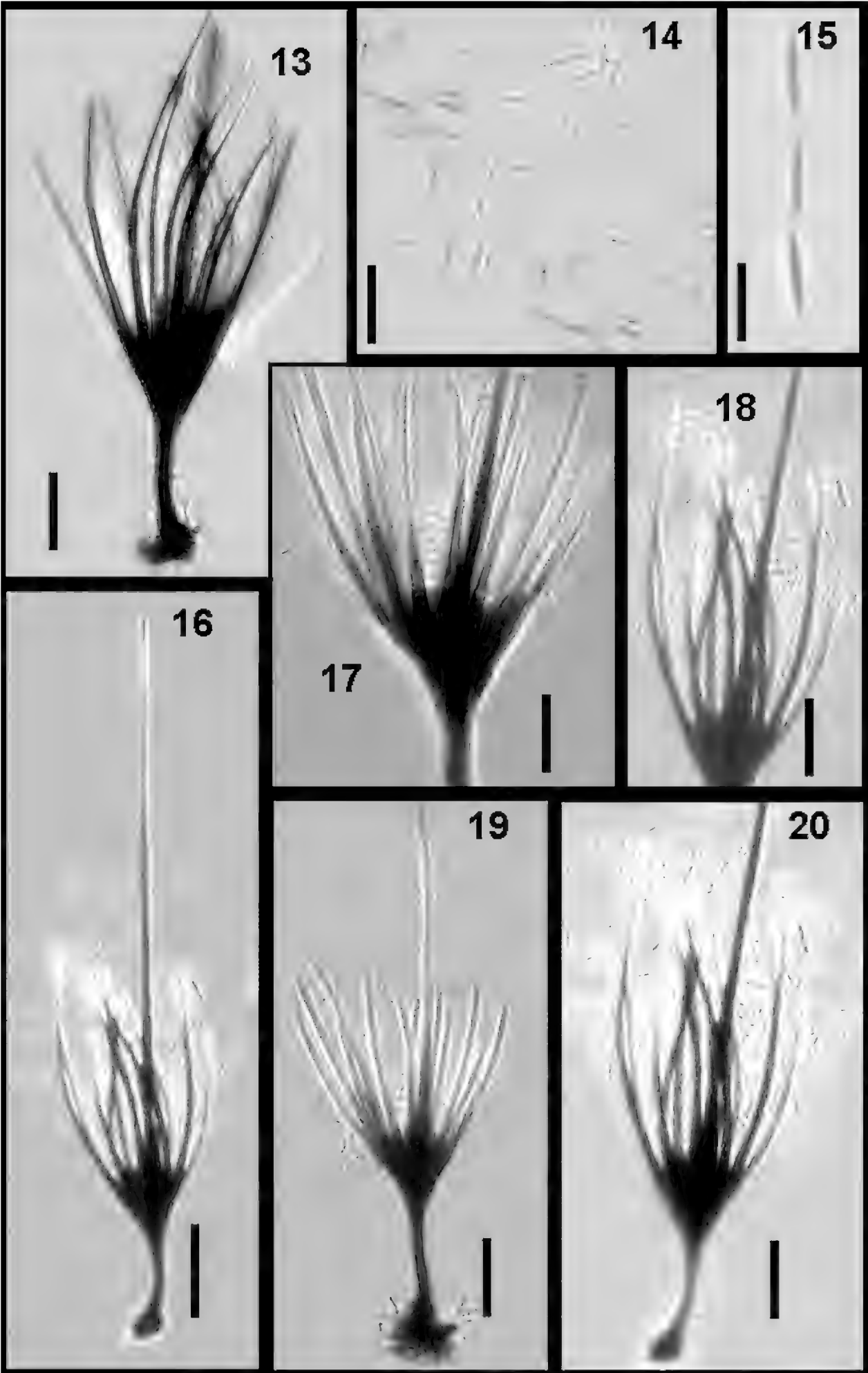
TYPE: BRAZIL, RIO DE GRANDE DO NORTE, “SERIDO”, on decaying leaf of an unidentified dicotyledons plant. Coll. V.O. Moraes Junior, 24.V.2006, HUEFS120875 (holotype).

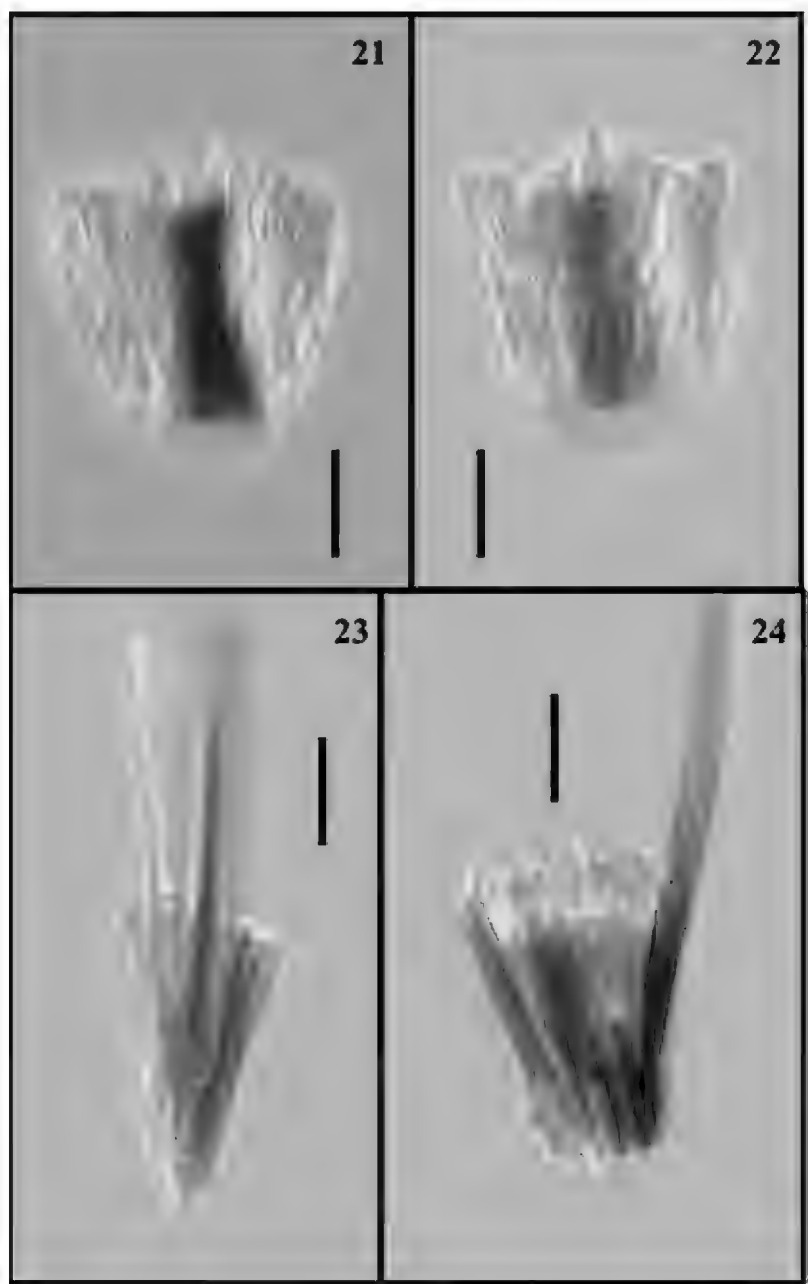
ETYMOLOGY: Latin, *grandiae* named in honor of Dr. Rosely Ana Piccolo Grandi, a recognized mycologist from Brazil.

COLONIES on the natural substratum effuse, black or dark brown. CONIDIOMATA synnematous, scattered, erect, straight, 350–450 × 17–25 µm (central setae excluded), dark red-brown to dark, composed of pale brown to brown, parallel, compact, 2–3 µm diam., septate peripheral hyphae, widening at the fertile apex; inner hyphae narrow, brown below and subhyaline to very pale brown towards the apex, smooth-walled, unbranched or rarely branched, giving rise to conidiophores. MARGINAL SETAE acuminate, curved, verrucose, sometimes tuberculate, dark red-brown, 125–260 × 6.0–7.5(–10) µm, originating from peripheral hyphae near fertile apex of the conidiomata. CENTRAL SETAE cylindrical, acuminate, erect, straight, up to 630 µm tall, 8–12 µm wide, verrucose, sometimes tuberculate, but smooth near the apex, 20–27-septate,

FIGS. 13–20. *Venustosynnema grandiae*, photomicrographs from holotype (HUEFS120875). FIGS. 13, 16–20. Setose synnemata. FIGS. 14–15. Conidia.

Scale is indicated by bars (FIGS 13, 16–20: 60 µm; FIG. 14: 10 µm; FIG. 15: 5 µm).



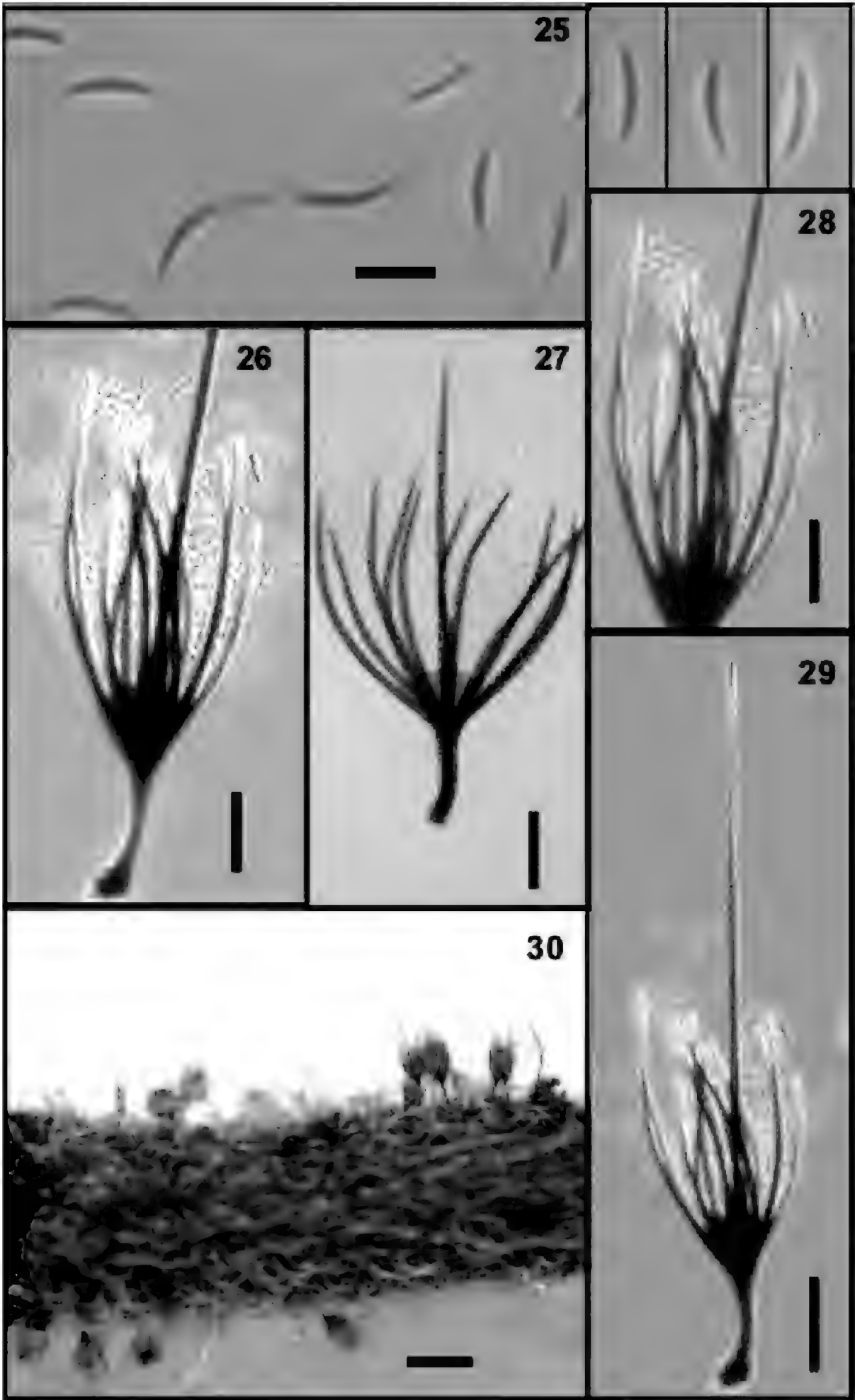


FIGS. 21–24. *Venustosynnema grandiae*, photomicrographs from holotype (HUEFS120875). Conidiogenous cells. Scale is indicated by bars (5 µm).

dark red-brown to dark brown or black, arising from the base of conidiomata. CONIDIOPHORES differentiated, mononematous, arising from parallel internal hyphae, tightly aggregated, unbranched or rarely branched, erect, straight, cylindrical, septate, smooth-walled, $100\text{--}125 \times 2\text{--}3.5\text{ }\mu\text{m}$, brown at the base and very pale brown to subhyaline towards the apex, arising from internal hyphae. CONIDIOGENOUS CELLS blastic-phialidic, unilocal, cylindrical to slightly subulate, forming a very compact turf, subhyaline, smooth, $10\text{--}22.5 \times 2\text{--}3.5\text{ }\mu\text{m}$, encircled by peripheral setae. CONIDIA blastic-phialidic, allantoid to

FIGS. 25–30 (right). *Venustosynnema grandiae*, photomicrographs from holotype (HUEFS120875). FIG. 25. Conidia. FIGS. 26–29. Setose synnemata. FIG. 25. Conidiomata on the substratum.

Scale is indicated by bars (FIG. 25: 10 µm; FIGS. 26–29: 60 µm; FIG. 30: 100 µm).



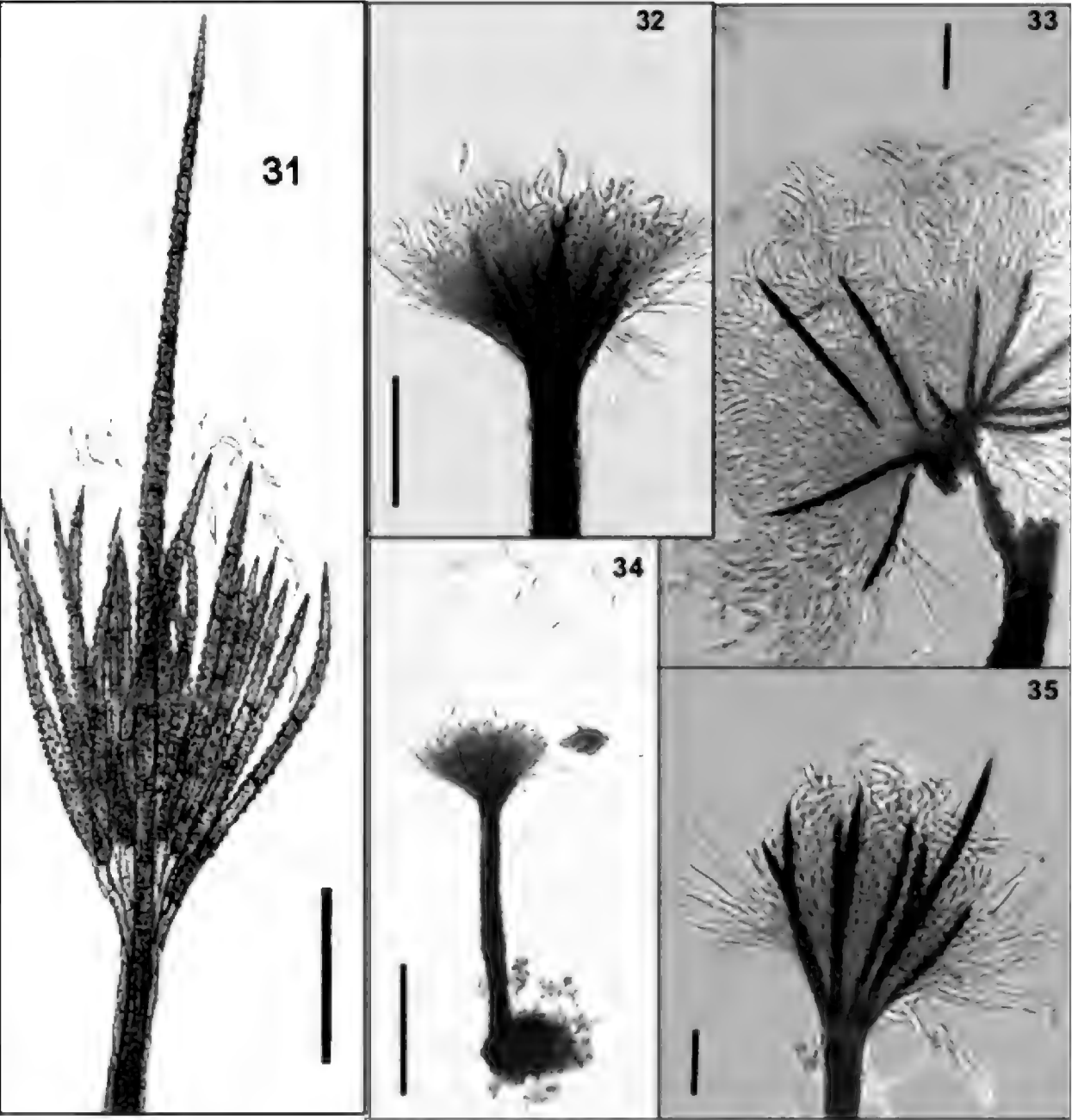


FIG. 31. *Venustosynnema grandiae*., drawing from holotype (HUEFS120875). Setose synnema and conidia. Scale is indicated by bar (100 μ m). FIGS. 32–35. *Venustosynnema ciliatum*, photomicrographs from holotype (INIFAT C82/51). Setose synnemata, conidiogenous cells and conidia. Scale is indicated by bars (Fig 32: 100 μ m; FIGS. 33, 35: 60 μ m; Fig 34: 200 μ m).

sub-lunate, 1-celled, hyaline, 6–8(–10) \times 1.5–2.0 μ m, with setula 4–7 μ m long at each end; accumulating in a white, mucous mass.

OTHER SPECIMEN EXAMINED: BRAZIL, BAHIA, MUNICIPIO DE CORIBE, “SERRA DO RAMALHO”, on petiole of decaying leaf of an unidentified plant. Coll. S.M. Leão-Ferreira Junior, 17.II.2008, HUEFS131817.

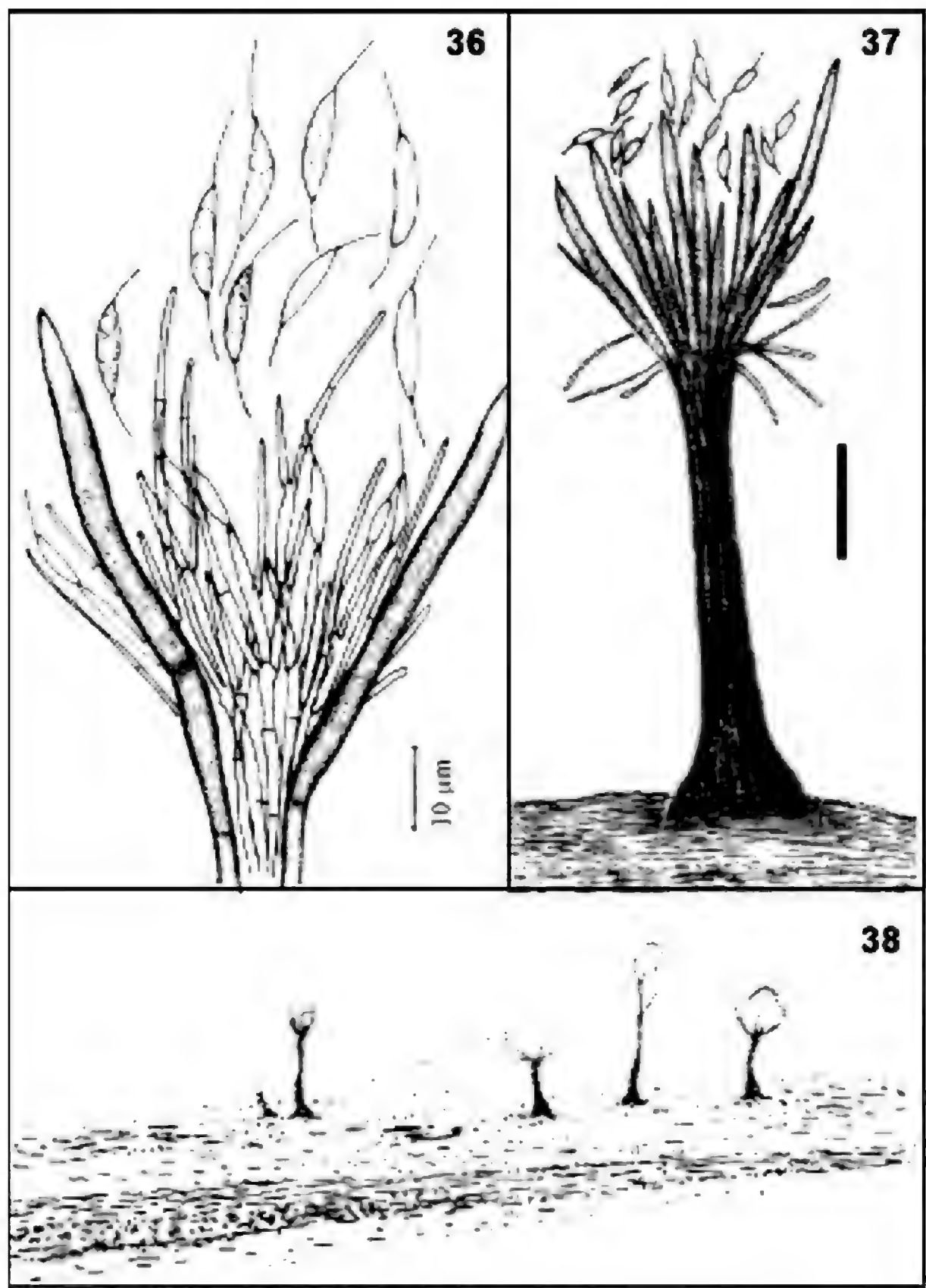
COMMENTS: *Venustosynnema* R.F. Castañeda & W.B. Kendr. (Castañeda & Kendrick 1990) was introduced to accommodate *Saccardaea ciliata* R.F. Castañeda et al. *Saccardaea* Cavara is a nom. dub. as was pointed out by Tulloch (1972), and Castañeda et al. (2002). Although the genus *Thozetella* Kuntze

shares some features with *Venustosynnema*, (phialidic conidiogenesis, aseptate, hyaline, curved conidia with an unbranched setula on each pole and synnematal conidiomata), the lack of microawns and the conspicuous marginal setae in *Venustosynnema* clearly differentiate both genera. Microawns are structures unique to *Thozetella* (Sutton & Cole 1983) and marginal or central setae have not been described from previously described species of *Thozetella* (Paulus et al. 2004, Allegrucci et al. 2004). Comparative analyses of *Venustosynnema* and *Thozetella* were made by Castañeda & Kendrick (1990) and Castañeda et al. (2002).

Other similar synnematosus anamorphic fungi that can be compared with *Venustosynnema* are *Menisporopsis* S. Hughes and *Paramenisporopsis* Matsush. In *Menisporopsis*, a compact, pale brown to brown, synnematosus group of conidiophores are disposed around a central or somewhat eccentric seta and the conidia are allantoid, lunate, falcate to cylindrical, hyaline, 0–1-septate, with one or several setula at each end or in diverse positions (Hughes 1968). In *Paramenisporopsis*, a compact or loosely arranged group of hyaline, synnematosus conidiophores are mixed with several brown setae that arise parallel or radially with the conidiophores; the conidia are cylindrical to ellipsoid, 1-septate, pale brown, with one or two cellular appendages at each end, produced in a brown mucous mass (Matsushima 2001). In order to distinguish the features among these genera the follow key is provided.

- Key to synnematosus anamorphic fungi that produce conidia with appendages**
- 1a. Conidiomata sporodochial or synnematal, brown, conidia hyaline, one-celled with a filiform appendage at each end, produced in white mucous masses, microawns sigmoid, uncinata, acerose or variable, always present, setae absent. . . . *Thozetella*
 - 1b. Conidiomata usually synnematosus, microawns absent, setae present2
 - 2a. Synnematosus conidiophores hyaline, one or several brown setae arising mixed together with the conidiophores, conidia cylindrical to ellipsoid, pale brown, 1-septate with 1–2 cellular appendage at each end, produced in brown mucous masses*Paramenisporopsis*
 - 2b. Synnematosus conidiophores pale brown, brown or black compact around a central seta, conidia hyaline, 0–1 septate, with 1 or several filiform, extra-cellular appendages.3
 - 3a. Marginal setae arising from parallel synnematal hyphae absent *Menisporopsis*
 - 3b. Marginal setae arising from parallel peripheral hyphae always present *Venustosynnema*

Venustosynnema grandiae can be easily differentiated from *V. ciliatum* by central setae that are present in the former species, and by the ornamentation, color and size of setae and conidia dimensions of both species.



FIGS. 36–38. *Venustosynnema ciliatum*, drawings from holotype (INIFAT C82/51). FIGS. 36–37. Setose synnemata, setae, marginal hyphae, conidiogenous cells and conidia. FIG. 38. Conidiomata on the substratum. Scale is indicated by bars (Fig 36: 10 µm; FIG. 37: 20 µm; FIG. 38: 1 mm).

Venustosynnema ciliatum (R.F. Castañeda, G.R.W. Arnold & A.G. Guerra)

R.F. Castañeda & W.B. Kendr., University of Waterloo Biology Series 32: 45

(1990).

FIGS. 32–38

COLONIES on natural substratum, effuse, black. CONIDIOMATA synnematos, scattered, determinate, erect, straight or curved, unbranched setose towards the apex, black, $300\text{--}500 \times 19\text{--}42 \mu\text{m}$, becoming $85\text{--}200 \mu\text{m}$ wide at the apex. MARGINAL SETAE cylindrical, acerose, septate, smooth, dark brown to black, $130\text{--}160 \times 4\text{--}5 \mu\text{m}$, originating from many of peripheral hyphae of the synnemata. CENTRAL SETAE absent. CONIDIOPHORES macronematous, mononematous, simple or slightly branched, septate, subhyaline or hyaline above, brown below, arising from internal hyphae, giving rise to both conidiogenous cells and sterile apices. CONIDIOGENOUS CELLS blastic-phialidic, unilocal, cylindrical or subulate, discrete, determinate, colorless, $17\text{--}30 \times 2\text{--}3 \mu\text{m}$, smooth, with marked periclinal wall thickening, $0.5\text{--}1 \mu\text{m}$ deep. CONIDIA lunate or sub-lunate to allantoid, unicellular, smooth, guttulate, colorless, $13\text{--}16 \times 2\text{--}4 \mu\text{m}$, with setula $6\text{--}9 \mu\text{m}$ long at each end, seriate, forming white, mucous masses.

SPECIMEN EXAMINED (HOLOTYPE): CUBA, CIEGO DE AVILA, on dead stem *Sorghum halepense* (L.) Pers., Coll. R.F. Castañeda, 26.IV.1982, INIFAT C82/51.

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Literature cited

- Allegrucci N, Cazau MC, Cabello MN, Arambarri AM. 2004. *Thozetella buxifolia* sp. nov. – a new hyphomycetes from Argentina. Mycotaxon 90: 275–279.
- Castañeda Ruíz RF. 1985. Deuteromycotina de Cuba. Hyphomycetes III. Instituto de Investigaciones Fundamentales en Agricultura Tropical “Alejandro de Humboldt”, Havana, Cuba, 42 pp, 30 figs.
- Castañeda Ruiz RF, Kendrick B. 1990. Conidial fungi from Cuba: I. Univ. Waterloo Biol. Ser. 32: 53 pp.
- Castañeda Ruiz RF, Minter DW, Rodríguez Hernández M. 2002. *Venustosynnema ciliatum*. IMI Description of Fungi and Bacteria No. 1490.
- Da Cruz ACR, Marques MFO, Gusmão LFP. 2007. Fungos anamórficos (Hyphomycetes) da chapada diamantina: novos registros para o estado da Bahia e Brasil. Rev. Brasileira Bot. 21: 847–855.
- Grandi RAP, Gusmão LFP. 1996. Hyphomycetes descompositores de raízes de *Calathea zebrina* (Sims) Lindl. (Marantaceae), provenientes da reserva biológica do alto da Serra de Paranapiacaba, Santo André, SP, Brasil. Rev. Brasileira Bot. 19: 165–172.

- Grandi RAP, Gusmão LFP. 2002. Hyphomycetes descompositores do folhedo de *Tibouchina pulchra* Cogn. Rev. Brasileira Bot. 25: 79–87.
- Hughes S. 1968. New Zealand Fungi 12. *Menispora*, *Codinaea*, *Menisporopsis*. N. Z. J. Bot. 6: 323–375.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the Fungi 10th Edition, CAB International, Oxon, UK, 771 pp.
- Matsushima T. 2001 Matsushima Mycological Memoirs 10. Matsushima Fungus Collection. Kobe, Japan. 214 pp.
- Paulus B, Gadek P, Hyde KD. 2004. Phylogenetic and morphological assessment of five new species of *Thozetella* from an Australian rainforest. Mycologia 96: 1074–1087.
- Sutton BC. 1973. Some hyphomycetes with holoblastic sympodial conidiogenous cells. Trans. Brit. Mycol. Soc. 61: 417–429.
- Sutton BC, Cole GT. 1983. *Thozetella* (Hyphomycetes), an exercise in diversity. Trans. Brit. Mycol. Soc. 81: 97–107.
- Tulloch M. 1972. The genus *Myrothecium*. Mycol. Pap. 130: 1–42.
- Walker JC, Minter DW. 1981. Taxonomy of *Nematogonium*, *Gonatobotrys* and *Gonatorrhodiella*. Trans. Brit. Mycol. Soc. 77: 489–500.

A new species of *Bipolaris* from the halophyte *Sesuvium portulacastrum* in Guangdong Province, China

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Abstract — A new non-graminicolous species found to infect *Sesuvium portulacastrum* (Aizoaceae) in China is introduced. *Bipolaris sesuvii* is characterized by straight, subcylindrical conidia with monopolar germination. Phylogenetic analysis based on ITS rDNA sequences show that *B. sesuvii* clusters with *B. indica*, which is distinguished by its straight, short clavate conidia. The combination of DNA sequence and morphological data indicate that *B. sesuvii* is a distinct species of *Bipolaris*. Pathogenicity tests also confirm that *Sesuvium portulacastrum* (sea purslane) is a natural host of *B. sesuvii* causing leaf lesions, leaf blight, or leaf rot and stem lesions.

Key words — fungus, taxonomy, systematics, phylogeny

Introduction

Among the 115 species of the genus *Bipolaris* listed in Index Fungorum, there are more than sixty non-graminicolous species, including a few species of human pathogens. The graminicolous species of *Bipolaris* were monographed by Sivanesan (1987). Since then, eleven new species of *Bipolaris* (Chiang et al. 1989, Peng & Liu 1989, Sisterna 1989, Alcorn 1990, Chen et al. 2000, Deng & Zhang 2002) have been described.

Bipolaris species are associated with *Cochliobolus* teleomorphs. The similar anamorph genera *Drechslera* and *Exserohilum* are associated with *Pyrenophora* and *Setosphaeria* teleomorphs, respectively. Although Shoemaker (1959) previously included all three anamorph genera within the genus *Helminthosporium* and differences in conidial morphology are sometimes too slight to distinguish the three anamorphic genera (Subramanian & Jain 1966, Ellis 1971, Chidambaram et al. 1973), ascospore shape, septation, and color easily distinguishes *Cochliobolus* from *Pyrenophora* and *Setosphaeria*. For, Where the teleomorph is unknown, many species of *Helminthosporium* sens. lat. have been assigned to any of the three teleomorphic genera, *Drechslera*, *Bipolaris*, or *Exserohilum* (Zhang & Berbee 2001).

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Molecular analyses of various gene regions (e.g. glyceraldehyde-3-phosphate, internal transcribed spacer (ITS), LSU rDNA) have been used to resolve phylogenetic relationships of pleosporaceous fungi (Berbee et al. 1999, Olivier et al. 2000, Zhang & Berbee 2001, Dela Paz et al. 2006, Kodsueb et al. 2006, Zhang et al. 2008).

In *Cochliobolus*, sequence comparisons indicate that the genus is monophyletic and clusters into two groups. Among the many previously misidentified isolates, CBS403.72 has been revised from *Pyrenophora bromi* to *Bipolaris portulacae* (Zhang & Berbee 2001). Some diagnostic characters, such as bipolar germination of conidia, are affected by environmental conditions (e.g. culture media). Bipolar conidial germination is considered an important taxonomic character in *Bipolaris*, but *B. oryzae* conidia regularly exhibit the intercalary germination more commonly observed in *Drechslera*. ITS sequence analyses by Dela Paz et al. (2006), however, identified all isolates as *B. oryzae*, irrespective of whether conidial germination in the culture was observed as bipolar, intercalary, or monopolar. This demonstrates that rDNA sequences (particularly the internal transcribed spacers ITS1 and ITS2) are useful tools for resolving taxonomic relationships within *Bipolaris* and among species of many other genera (e.g. *Ampelomyces*, Liang et al. 2007; *Dactylella*, Chen et al. 2007; *Cordyceps*, Wang et al. 2008; *Xylariaceae*, Peláez et al. 2008).

Recently, in the Zanjia District of Guangdong Province, China, we encountered a species of *Bipolaris* infecting *Sesuvium portulacastrum* in sand dunes, salt marshes, and mangrove swamps that did not match any currently accepted species of this genus. Here we describe the new species and compare it both morphologically and molecularly (based on ITS sequence data) to other *Bipolaris* species. Inoculation tests were conducted to confirm the pathogenicity of the new *Bipolaris* to *Sesuvium portulacastrum*.

Materials and methods

Collection of isolates

Disease symptoms were noted on leaves and stems of *Sesuvium portulacastrum* (Aizoaceae). Isolates of a *Bipolaris* were derived from representative single lesions. Conidia (removed directly from sporulating lesions on leaves) and small pieces of diseased tissue (excised from the lesion margins) were placed on PDA (potato-dextrose agar) containing rifampicin. Isolates (Bp-zj 01, Bp-zj 02, Bp-zj 03) were transferred to fresh PDA plates, and conidia from these cultures were stored in 20% glycerol in 1.5 mL cryotubes at -70°C .

Morphological and cultural studies

Conidia and conidiophores taken from lesions were examined in distilled water. In order to observe fungal morphology on media, small pieces of frozen conidial suspensions were removed from stock-culture cryotubes without thawing, and

transferred to Petri dishes containing PDA. Single conidial isolates were prepared and grown on PCA (potato carrot agar) and WSA (water agar + wheat straw) from conidia produced on these Petri dishes. Colonies were grown at 25°C under 12 h of alternate darkness and fluorescent light. Measurement and microphotographs were taken from slide mounts in lactophenol.

DNA extraction

Fungal isolates were cultured on PDA at 25°C under cool fluorescent illumination. After four days, five mycelial disks were excised from the margins of colonies and inoculated into 100 mL of liquid growth media (PD broth) in 250 mL flasks, shaken at 200 rpm at 25°C for 3–5 d. Mycelia were harvested by filtration, freeze dried, ground to a fine powder in liquid nitrogen, and then stored at –70°C. About 50 mg of mycelial powder was removed into a sterile 1.5 mL tube, rehydrated in 600 µL of 2 × CTAB buffer (100 mM Tris, pH 8.0, 1.4 M NaCl, 30 mM EDTA, 2% hexadecyltri-methylammonium bromide) and incubated in a water bath at 65°C for 30–60 min. Following a phenol/chloroform extraction, the genomic DNA was precipitated by isopropanol in the presence of sodium acetate and visualized in 1% agarose gels after ethidium bromide staining.

Amplification of ITS regions

The rDNA ITS regions were amplified using primers ITS6 (5' GAAGGTGAA GTCGTAACAAGG 3') and ITS4 (5'- TCCTCCGCTTATTGATATGC) (Cooke & Duncan 1997). PCR amplifications were performed in a total volume of 50 µL containing 40 mM of Tris-HCl (pH 8.4), 100 mM of KCl, 3 mM of MgCl₂, 400 µM of each dNTP, 1 µM of each primer, and 0.5 U of Taq. PCR amplifications were carried out on a DNA thermal cycler (PTC-150 MiniCycler, MJ RESEARCH Corp.). Following an initial denaturation at 95°C for 4 min, the DNA templates were amplified for 35 cycles. Each cycle consisted of a denaturation step at 95°C for 1 min, an annealing step at 55°C for 1 min, and an extension step at 72°C for 1.5 min. At the end a final extension step (72°C for 10 min) was included. After 4 µL aliquots of the amplification products were electrophoresed on 1% agarose gels, the PCR products were stained with ethidium bromide; successful products produced a single DNA band (corresponding to ~600bp). PCR products were purified using a Biolight PCR Purification Kit (Shanghai Biolight Technology Co., Ltd) according to the manufacturer's instructions.

Sequencing and analysis of rDNA-ITS region

The purified PCR products were submitted to Hangzhou Genomics Institute for sequencing in both directions. Sequence files were assembled and edited, and consensus sequences were constructed using DNAMAN 4.0 (Lynnon bioSoft). The ITS sequences were submitted to the GenBank database, and ITS1, ITS2 and 5.8S rDNA sequences from 33 other fungal isolates were downloaded from GenBank (TABLE 1); *Leptosphaeria tompkinsii* was selected as an outgroup. Sequences were aligned using CLUSTAL X (Thompson et al. 1994). Phylogenetic analyses were performed using PAUP test Version 4.0b10 (PPC; David Swofford, Smithsonian Institution, Washington DC.). Phylogenetic trees were inferred from the ITS sequence data set using parsimony analysis with all characters weighted equally and unordered.

Pathogenicity testing

Laboratory tests were conducted on apparently healthy leaves collected from the upper part of a plant without any disease occurrence. An aqueous inoculation suspension ($1\text{--}2 \times 10^5$ conidia/mL) was prepared from 8–10-day old cultures. Leaves were washed three times with sterile water; each was inoculated with 100 μL of conidial suspension and placed on Petri dishes containing wet filter paper. Control leaves were inoculated with 100 μL sterile water. Petri dishes were placed in a 26–27°C incubator with 12 h of alternate darkness and fluorescent light. The treatments were replicated ten times. The fungus was re-isolated by cutting small portions from the margin of lesions; these were surface sterilized and placed on PDA plates.

Results and discussion

Symptoms on sea purslane

The leaves and stems of *Sesuvium portulacastrum* were infected with leaf lesions, leaf blight or leaf rot, and stem lesions. On leaves, symptoms first appeared as tiny, sunken, light tan to straw-colored flecks with brown borders (FIG. 1). These flecks expanded and became circular or oval brown lesions with a dark brown center. Under moist conditions, the lesions expanded rapidly and the entire leaf or parts of the leaf became water-soaked and brownish. Subsequently, the infected portions became dark purple-brown to dark brown, sometimes with a superficial layer of white mycelium (FIG. 2), and leaf rot or leaf blight occurred as a rapid collapse and drying of the leaves (FIG. 3). Symptoms sometimes occurred on stems as small spots. These spots were light tan to straw-colored, oval to elliptical, with brown borders, often surrounded by a purple-red halo.

New species

Bipolaris sesuvii Jing.Z. Zhang, sp. nov.

FIGS. 3–6

MYCOBANK MB511136

Conidiophora singularia vel fasciculate, simplicia, raro ramosa, medio olivaceobrunnea, versus apicem pallidiora, geniculata vel infra recta, super geniculata, cicatrices, multiseptata, 86–160(–212) μm longa, ad basim tumida 7–10 μm diam, prope basim 6.2–7(–7.5) μm diam, ad apicem 5.5–7 μm diam. Conidia olivaceobrunneae vel brunneae, cylindrical vel late fusioidea, recta, laevia, concolorata, 5–9 distoseptata, 52–77 \times 13–16 μm , truncate hilo leviter protrudenti vel non protrudenti..

TYPE: CHINA: Zanjia, Guangdong, on *Sesuvium portulacastrum* (Aizoaceae), 20 Aug. 2006, J.Z. Zhang (holotype HMAS 163207).

ETYMOLOGY: referring to the genus *Sesuvium* on which this fungus was collected and to which it was virulent.

Conidiophores single or fasciculate in small groups, simple, rarely branched once apically, medium olivaceous-brown below, paler at the apex when found on a natural host, geniculate or straight in sterile part, then becoming slightly to distinctly geniculate, cicatrized with scars often inflated and lightly

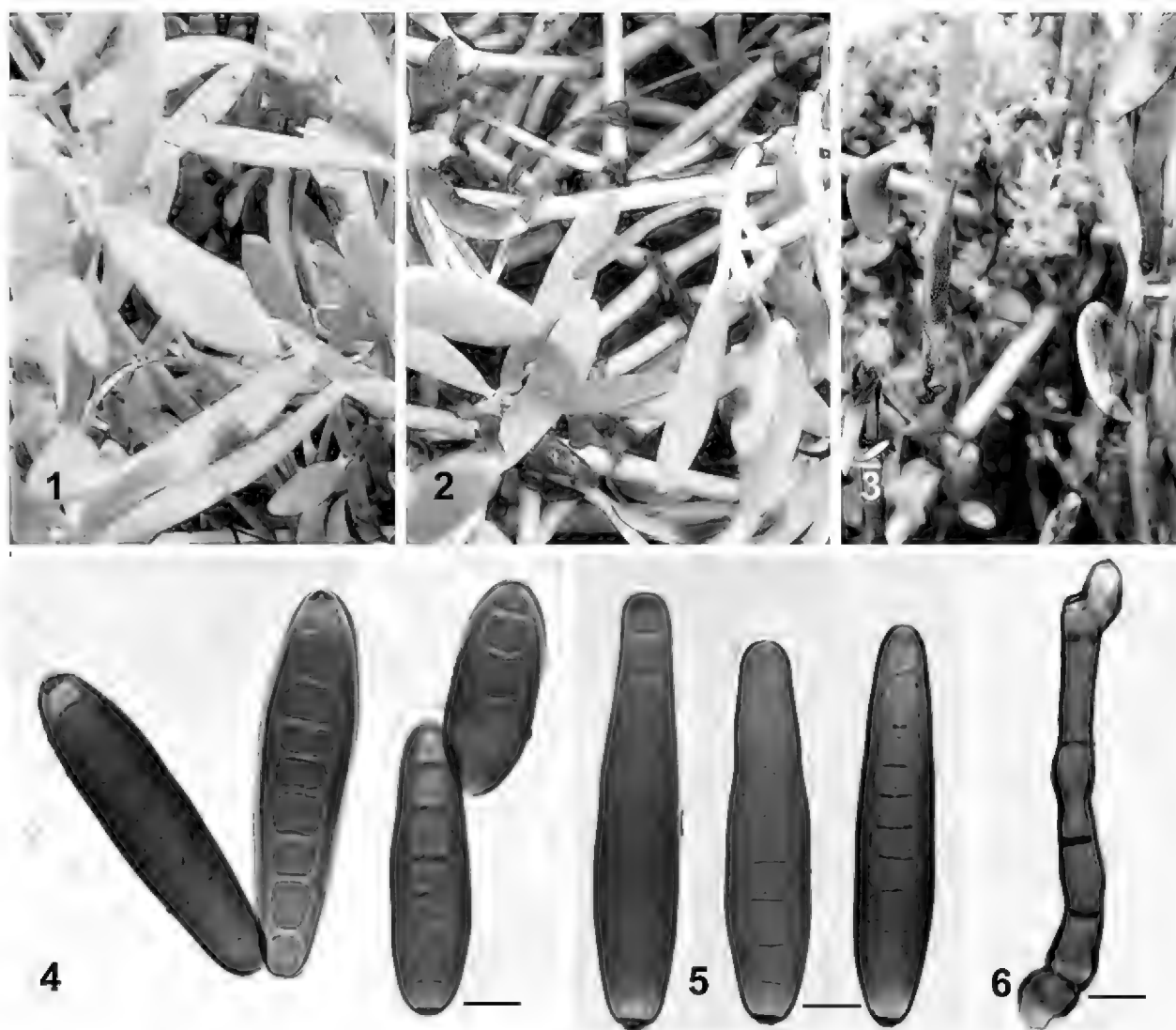


FIG. 1–3. Symptoms on *Sesuvium portulacastrum* caused by *Bipolaris sesuvii*. 1. Leaf spots. 2. Leaf rot. 3. Leaf blight. FIG. 4–6. Conidia and conidiophore from host. 4. Conidia. 5. Representative conidia. 6. Conidiophore. Bars = 10 μ m.

verruculose, multiseptate, 86–160(–212) μ m long, swollen to 7–10 μ m diam at base, then narrowing to 6.2–7(–7.5) μ m diam (middle) and 5.5–7 μ m diam (apex). Conidia olivaceous-brown to brown, basal cell concolorous or slightly pale, subcylindrical to broadly fusoid and rounded at ends, straight, smooth, 5–9 distoseptate, $52\text{--}77 \times 13\text{--}16$ μ m, hilum ≤ 2 μ m diam, sometimes slightly protruding.

CULTURAL CHARACTERISTICS: Colony velvety, floccose, olivaceous-brown to dark brown on PDA. Germination of conidia is monopolar. Conidia maturing with first septum occurring at the median, the second delimiting the basal cell, and the third distal.

COLLECTIONS EXAMINED: CHINA: Zanzhang, Guangdong, on *Sesuvium portulacastrum* (Aizoaceae), 20 Aug. 2006, J.Z. Zhang (HMAS 163207, holotype); exatype living cultures CGMCC 3.9578 (Bp-zj 01), CGMCC 3.9579 (Bp-zj 02) and CGMCC 3.9580 (Bp-zj 03) deposited in the collection of Biotechnology Institute, Zhejiang University, Zhejiang Province, China.

TABLE 1. Source isolates and sequences.

SPECIES	ISOLATE/STRAIN	SOURCE	GENBANK
<i>Bipolaris australiensis</i> (M.B. Ellis) Tsuda & Ueyama	Alcorn 8320b	Berbee ^a	AF081450
<i>B. australis</i> Alcorn	Turgeon 77139	Berbee ^b	AF081448
<i>B. cynodontis</i> (Marignoni) Shoemaker	BRIP16821	Goh & Hyde ^b	AF163093
<i>B. dactyloctenii</i> Alcorn	Alcorn 7938-10	Berbee et al. ^a	AF158106
<i>B. eleusines</i> Alcorn & R.G. Shivas	Alcorn 8749c	Berbee ^a	AF08145
<i>B. ellisii</i> (Danquah) Alcorn	Alcorn 81154-1	Berbee et al. ^a	AF071323
<i>B. hawaiiensis</i> (M.B. Ellis) J.Y. Uchida & Aragaki	Alcorn 7612(b)-6	Berbee et al. ^a	AF071324
<i>B. heveae</i> (Petch) Arx	Cyn-2	Tsukiboshi et al. ^c	AB179835
<i>B. indica</i> J.N. Rai et al.	BRIP 17439	Berbee ^a	AF081449
<i>B. kusanoi</i> (Y. Nisik.) Shoemaker	Tsuda Ck2	Yun et al. ^a	AF071352
<i>B. perotidis</i> Alcorn	Alcorn 7846-2	Berbee et al. ^a	AF071320
<i>B. portulacae</i> (Rader) Alcorn	CBS 403.72	Zhang & Berbee ^a	AY004779
<i>B. portulacae</i>	CBS 239.48	Zhang & Berbee ^a	AY004778
<i>B. portulacae</i>	DAOM 208494	Zhang & Berbee ^a	AY004780
<i>B. ravenelii</i> (M.A. Curtis) Shoemaker	Alcorn 7979-6	Berbee et al. ^a	AF071321
<i>B. sesuvii</i>	Bp-zj 01	This study	EF175940
<i>B. sesuvii</i>	Bp-zj 02	This study	EF175941
<i>B. sesuvii</i>	Bp-zj 03	This study	EF175942
<i>B. sorokiniana</i> (Sacc.) Shoemaker	Tinline A20	Berbee et al. ^a	AF071329
<i>B. tetramera</i> (McKinney) Shoemaker	CBS 371.72	Zhang & Berbee ^a	AY004777
<i>B. victoriae</i> (F. Meehan & H.C. Murphy) Shoemaker	Macko HVW	Berbee et al. ^a	AF158109
<i>B. zeae</i> Sivan.	Alcorn 8641a	Berbee ^a	AF081452
<i>Curvularia affinis</i> Boedijn	DAOM 46365	Berbee et al. ^a	AF071335
<i>C. clavata</i> B.L. Jain	DAOM 148084	Berbee et al. ^a	AF071336
<i>C. cymbopogonis</i> (C.W. Dodge) J.W. Groves & Skolko	Alcorn 88109-1	Yun et al. ^a	AF071351
<i>C. gladioli</i> Boerema & Hamers	DAOM 164725	Berbee et al. ^a	AF071337
<i>C. inaequalis</i> (Shear) Boedijn	CBS 185.47	Olivier et al. ^d	AF120261
<i>C. inaequalis</i>	BRIP14448	Goh & Hyde ^b	AF163081 ^f
<i>C. intermedia</i> Boedijn	Alcorn 8797-1	Berbee et al. ^a	AF071327
<i>Drechslera biseptata</i> (Sacc. & Roum.) M.J. Richardson & E.M. Fraser	CBS 108940	Zhang & Berbee ^a	AY004788
<i>D. tritici-repentis</i> (Died.) Shoemaker	DAOM 208990	Berbee et al. ^a	AF071348
<i>D. tuberosa</i> (G.F. Atk.) Shoemaker	DAOM 169286	Berbee et al. ^a	AF071347
<i>Exserohilum gedarefense</i> (El Shafie) Alcorn	8307	Goh & Hyde ^b	AF163068
<i>E. monoceras</i> (Drechsler) K.J. Leonard & Suggs	DAOM 208988	Berbee et al. ^a	AF071340
<i>E. rostratum</i> (Drechsler) K.J. Leonard & Suggs	BRIP23191	Goh & Hyde ^b	AF163066
<i>Leptosphaeria tompkinsii</i> El-Ani	IP 1156.77	Desnos et al. ^e	DQ836789

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COMMENTS: Its conidial morphology clearly establishes our specimen as a species of *Bipolaris*. It is morphologically similar to *B. cynodontis* and *B. perotidis* (Sivanesan 1987). The conidia of *B. cynodontis* are of a similar size ($37\text{--}75 \times 10\text{--}16$ mm) but the conidia are mostly slightly curved and are 3–9, commonly 7–8 distoseptate, with bipolar germination (Sivanesan 1987). The conidia of *B. perotidis* are straight and similar in shape to those of *B. sesuvii*. However, *B. perotidis* has narrower conidia ($55\text{--}75 \times 7.5\text{--}12.5$ mm) with fewer distosepta (3–7).

Phylogenetic analysis

The ITS1-5.8S-ITS2 rDNA sequences of the three *Bipolaris sesuvii* strains were identical. A GenBank blast search showed a 99% identity similarity with the partial ITS1 of *B. indica* (accession no. AF081449), differing in one base pair in each of the ITS1 and ITS2 regions and a 33 bp indel within ITS1. The *B. sesuvii* sequence also showed a 94% similarity (26 bp difference) with *B. portulacae* (accession no. AY004780) (FIG. 7). Both *B. indica* and *B. portulacae* are considered non-graminicolous species.

A parsimony tree was constructed from the ITS1-ITS2 rDNA regions (424 characters) from 36 fungal isolates (TABLE 1). The parsimony bootstrap consensus tree (FIG. 8) indicates that *Pyrenophora*, *Cochliobolus* and *Setosphaeria* are monophyletic. The *Drechslera*/*Pyrenophora*, *Curvularia*/*Bipolaris*/*Cochliobolus*, and *Exserohilum*/*Setosphaeria* clades were supported by 100%, 76%, and 99% bootstrap values, respectively.

Bipolaris species clustered into two subclades within the *Curvularia*/*Bipolaris*/*Cochliobolus* clade with only *Bipolaris* isolates grouping in the *Cochliobolus* Group I subclade and *Bipolaris* and *Curvularia* isolates intermingling in the *Cochliobolus* Group II subclade. The three *B. sesuvii* isolates from *Sesuvium portulacastrum* had identical ITS sequences and clustered with *B. indica* in the *Bipolaris*/*Cochliobolus* Group II subclade with a 98% bootstrap value. Sequence variation between *B. sesuvii* and *B. indica* isolates reached a critical intraspecific–interspecific variability value similar to that found for other species, such as *B. portulacae* (FIG. 8). Other *Bipolaris* spp. have shown similarly high levels of intraspecific variability in rDNA regions. For example, the ITS similarity range for *B. portulacae* (CBS 403.72, CBS 239.48, DAOM 208494) is 93–100%. A similar clustering was obtained using neighbour-joining analysis. The three *B. sesuvii* isolates formed a single group together with the *B. indica* isolates (88% bootstrap value; data not shown). The rDNA sequence similarity alone does not provide sufficient information to delimit the relationship between *B. sesuvii* and *B. indica* and *B. portulacae*; however, conidial morphology of *B. sesuvii* differs from *B. indica* and *B. portulacae* (Rai et al. 1969, Alcorn 1990): *B. indica* conidia are clavate, but shorter and wider ($17\text{--}35$ mm) than those of


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Bp-zj 01      CACAAAAAGTATGAAGGCTGCACGCGGCTG-----
DAOM 208494   *****G*A*****T*****
BRIP 17439    *****TGGCCTCTTGGGGGCCAGCGGCGGGAGGCT

Bp-zj 01      -GATTATCTTTTTCACCCATGTCTTTGCGCACTTGTTGTTTCCTGGGCGGGTTCGCCCCG
DAOM 208494   *A*A***-****C*****-----*****
BRIP 17439    G*****-C*****

Bp-zj 01      CCACCAGGACCACACAATAAACCTTTTTTATGCAGTTGCAATCAGCGTCAGTAAACAA
DAOM 208494   *****C*****-*****C***T*
BRIP 17439    *****

Bp-zj 01      ATGTAAA-TCATTTACAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAAC
DAOM 208494   *****A*****
BRIP 17439    *****

Bp-zj 01      GCAGCGAAATGCGATACGTAGTGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAA
DAOM 208494   *****
BRIP 17439    *****

Bp-zj 01      CGCACATTGCGCCCTTTGGTATTCCAAAGGGCATGCCTGTTGAGCGTCATTTGTACCCT
DAOM 208494   *****
BRIP 17439    *****

Bp-zj 01      CAAGCTTTGCTTGGTGTGGGCGTTTTTTTGTCTTGCTGCAAGCAAGACTCGCCTTAAAA
DAOM 208494   *****G**-----*GATCC*****
BRIP 17439    *****

Bp-zj 01      CGATTGGCAGCCGGCCTACTGGTTTCGGAGCGCAGCACATTTTTTGGCCTTGCAACCAGC
DAOM 208494   *****A*****
BRIP 17439    *****

Bp-zj 01      AAAAGAGGTTGGCGATCCAGCAAGTCCATTTTCTCACTTT
DAOM 208494   *****A***C*****
BRIP 17439    *****C*****
```

FIG. 7. Aligned sequences of the internal transcribed spacer (ITS)1, 5.8S RNA gene and ITS2 of the three *Bipolaris sesuvii* isolates used in this study (Bp-zj 01) together with reference isolates of *B. portulacae* (DAOM 208494) and *B. indica* (BRIP 17439). An asterisk indicates identity with the first sequence and a dash indicates an introduced gap. The alignment was generated using CLUSTAL W (Thompson et al. 1994).

B. sesuvii (Sivanesan 1987); *B. portulacae* conidia are cylindrical, longer (138-190 × 11-14 mm), and with more distosepta (8-11) (Alcorn 1991). Combining both morphological characteristics and rDNA sequences similarity, we suggest that *B. sesuvii* is an unreported species that differs from *B. indica* and *B. portulacae* as well as other known *Bipolaris* species.

Pathogenicity testing

After 5-6 days *Bipolaris sesuvii* induced small flecks or expanded lesions on all *Sesuvium portulacastrum* leaves tested. Symptoms were similar to those observed in the wild, and no disease was found in the control leaves. In moist

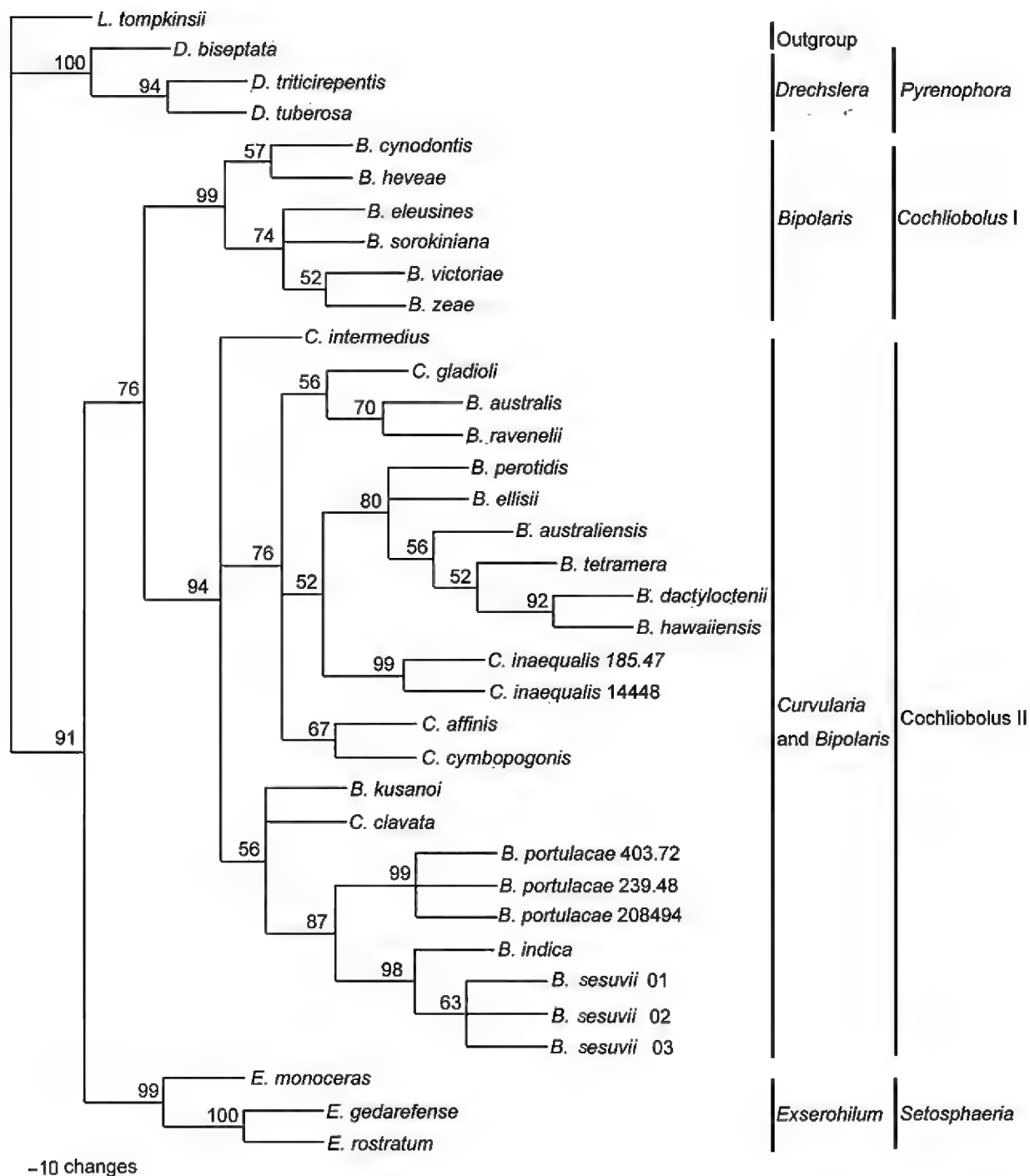


FIG. 8. A parsimony bootstrap consensus tree from complete sequence of ITS1 and ITS2 of 36 ribosomal RNA gene sequences with *Leptosphaeria tompkinsii* as the outgroup. The numbers are the percentage of times groups appeared in 1000 bootstrap replicates.

Petri dishes, lesions on *S. portulacastrum* began to sporulate within 48 h and sporulation was observed on all inoculated leaves by 72 h. The fungus was re-isolated from the infected parts; the colonies and morphology were consistent with original isolates. The results of pathogenicity tests suggest that sea purslane is a natural host of *B. sesuvii*.

The conidial morphological traits of *B. sesuvii* are relatively stable. It produced straight, subcylindrical conidia on different substrates, but there was some variation in conidial septation, length, and diameter. Conidial

TABLE 2. Conidial dimensions of *Bipolaris sesuvii*.

SUBSTRATE	NO. OF SEPTA ^a	LENGTH (mm)	WIDTH (mm)
Host	6.8 ± 1 ^b (5-9)	61.5 ± 7 (55-70)	14.5 ± 1.5 (13-16)
WSA	5.5 ± 1 (4-8)	51 ± 5.6 (42-59)	14.5 ± 1.7 (13-16)
PCA	6.0 ± 1 (4-9)	56.7 ± 14 (40-78)	14.2 ± 1.6 (13-16)
PDA	7.5 ± 1.4 (5-10)	70 ± 10.5 (49-86)	16.0 ± 0.97 (14.5-17.5)

^a Conidia produced in 8-10-day-old cultures.
^b Mean and standard deviation from 100 measurements; figures in parentheses represent the range.

dimensions (especially diameter) on WSA (Alcorn 1991) and PCA were closer to those on the host than on PDA (TABLE 2). The conidial morphology clearly differs from that of other known *Bipolaris* species. Although the teleomorph was not observed in cultures or on the natural host, the *B. sesuvii* teleomorph relationships can be compared by using differences or similarity in conserved DNA sequences to provide a more reliable classification system at the generic and species levels (Shenoy et al. 2007).

Berbee et al. (1999) used the ITS sequences and a portion of the glyceraldehyde-3-phosphate dehydrogenase sequences to evaluate *Cochliobolus* (anamorphs *Bipolaris*) and proposed that *Bipolaris* be divided further, separating species with large, canoe-shaped, gently curving conidia (*Cochliobolus* Group I) from those with short, either straight or curved conidia lacking a gentle curve along the whole spore length (*Cochliobolus* Group II), which are intermixed with *Curvularia* species. All *B. sesuvii* isolates used in this study clustered in the *Cochliobolus* Group II subclade, which contains *Bipolaris* species with short, straight or curved conidia; some species were the same as those analysed by Berbee et al. (1999), Dela Paz et al. (2006), Olivier et al. (2000), and Zhang & Berbee (2001). Although the conidial morphology of *B. sesuvii* is similar to *B. cynodontis* and *B. perotidis*, the phylogenetic analysis did not show a close relationship. The conidial morphology of *B. sesuvii* was distinct from that of *B. indica* and *B. portulacae*, but the phylogenetic evidence indicated that the *B. sesuvii* isolates were related to *B. indica* and *B. portulacae*. The combined molecular-morphological analysis support *B. sesuvii* as an unreported new species.

Acknowledgments

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Literature cited

- Alcorn JL. 1990. Additions to *Bipolaris*, *Cochliobolus* and *Curvularia*. Mycotaxon 39: 361–392.
- Alcorn JL. 1991. New combinations and synonymy in *Bipolaris* and *Curvularia*, and a new species of *Exserohilum*. Mycotaxon 41: 329–343.
- Berbee ML, Pirseyedi M, Hubbard S. 1999. *Cochliobolus* phylogenetics and the origin of known, highly virulent pathogens, inferred from ITS and glyceraldehyde-3-phosphate dehydrogenase gene sequences. Mycologia 91: 964–977.
- Chen J, Xu LL, Liu B, Li XZ. 2007. Taxonomy of *Dactylella* complex and *Vermispora*. I. Generic concepts based on morphology and ITS sequence data. Fungal Diversity 26: 73–83.
- Chen WQ, Swart WJ, Nieuwoudt TD. 2000. A new species of *Bipolaris* from South Africa. Mycotaxon 76: 149–152.
- Chiang MY, Leonard K, Van Dyke C. 1989. *Bipolaris halepense*: a new species from *Sorghum halepense* (johnsongrass). Mycologia 81: 532–538.
- Chidambaram P, Mathus SB, Neegaard P. 1973. Identification of seed-borne *Drechslera* species. Friesia 10: 165–207.
- Cooke DEL, Duncan JM. 1997. Phylogenetic analysis of *Phytophthora* species based on the ITS1 and ITS2 sequences of ribosomal DNA. Mycological Research 101: 667–677.
- Dela Paz MAG, Goodwin PH, Raymundo AK, Ardales EY, Vera Cruz CM. 2006. Phylogenetic analysis based on ITS sequences and conditions affecting the type of conidial germination of *Bipolaris oryzae*. Plant Pathology 55: 756–765.
- Deng H, Zhang TY. 2002. Taxonomic studies of *Bipolaris* from China I. Mycosystema 21: 327–333.
- Ellis MB. 1971. Dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew.
- Kodsueb R, Jeewon R, Dhanasekaran V, McKenzie EHC, Lumyong P, Lumyong S, Hyde KD. 2006. Systematic revision of *Tubeufiaceae* based on morphological and molecular data. Fungal Diversity 21: 105–130.
- Liang C, Yang J, Kovács GM, Szentiványi O, Li B, Xu XM, Kiss L. 2007. Genetic diversity of *Ampelomyces* mycoparasites isolated from different powdery mildew species in China inferred from analyses of rDNA ITS sequences. Fungal Diversity 24: 225–240.
- Olivier C, Berbee ML, Shoemaker RA, Loria R. 2000. Molecular phylogenetic support from ribosomal DNA sequences for origin of *Helminthosporium* from *Leptosphaeria*-like loculoascomycete ancestors. Mycologia 92: 736–746.
- Peláez F, González V, Platas G, Sánchez-Ballesteros J, Rubio V. 2008. Molecular phylogenetic studies within the family Xylariaceae based on ribosomal DNA sequences. Fungal Diversity 31: 111–134.
- Peng JH, Lu JY. 1989. Studies on *Bipolaris*, *Drechslera* and *Exserohilum*. Journal of Nanjing Agricultural University 12: 46–53.
- Rai JN, Wadhwani K, Tewari JP. 1969, (1970). *Bipolaris indica* spec. nov. Sydowia 23: 8–10.
- Shenoy BD, Jeewon R, Hyde KD. 2007. Impact of DNA sequence-data on the taxonomy of anamorphic fungi. Fungal Diversity 26: 1–54.
- Shoemaker RA. 1959. Nomenclature of *Drechslera* and *Bipolaris*, grass parasites segregated from *Helminthosporium*. Canadian Journal of Botany 37: 879–887.
- Sisterna MN. 1989. Two new species of *Bipolaris*. Plant Pathology 38: 98–100.
- Sivanesan A. 1987. Graminicolous Species of *Bipolaris*, *Curvularia*, *Drechslera*, *Exserohilum* and their Teleomorphs. Mycological Papers. No. 158.
- Sivanesan A. 1992. New *Bipolaris*, *Curvularia* and *Exserohilum* species. Mycological Research 96: 485–489.

- Subramanian CV, Jain BL. 1966. A revision of some graminicolous Helminthosporia. *Current Science* 14: 352–355.
- Thompson J, Higgins D, Gibson T. 1994. Clustal W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic Acids Research* 22: 673–680.
- Wang L, Zhang WM, Hu B, Chen YQ, Qu LH. 2008. Genetic variation of *Cordyceps militaris* and its allies based on phylogenetic analysis of rDNA ITS sequence data. *Fungal Diversity* 31: 147–155.
- Zhang G, Berbee M. 2001. *Pyrenophora* phylogenetics inferred from ITS and glyceraldehyde-3-phosphate dehydrogenase gene sequences. *Mycologia* 93: 1048–1063.
- Zhang Y, Fournier J, Pointing SB, Hyde KD. 2008. Are *Melanomma pulvis-pyrius* and *Trematosphaeria pertusa* congeneric? *Fungal Diversity* 33: 47–60.

***Manoharachariella*, a new dematiaceous hyphomycetous genus from India**

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Abstract — A new hitherto undescribed anamorphic dematiaceous hyphomycetous genus with monoblastic, integrated conidiogenous cells producing solitary, doliiform, obpyriform, dictyoseptate, apiculate, conidia collected on dead twigs in a forest near Darakonda, Andhra Pradesh, India is described as *Manoharachariella* gen. nov.

Key words — macronematous, acroauxic, tiered, apiculus, *Manoharachariella lignicola*

During a survey of hyphomycetes of Andhra Pradesh a new anamorphic genus was collected on unidentified dead twigs in a forest near Darakonda, Distt. Visakhapatnam, Andhra Pradesh, India. It is characterized by the presence of macronematous, mononematous conidiophores with monoblastic, acroauxic, integrated conidiogenous cells producing solitary, doliiform, obpyriform, dictyoseptate, apiculate conidia. A critical microscopic examination of the fungus and perusal of literature (Ellis 1971, 1976; Matsushima 1975, 1983, 1996; Carmichael et al. 1980, Castañeda 1986, Mercado-Sierra 1984, Mercado-Sierra et al. 1997, Vasanth Rao & de Hoog 1986) revealed it to be hitherto undescribed dematiaceous hyphomycetous genus.

***Manoharachariella* Bagyan., N.K. Rao & Kunwar gen. nov.**

MYCOBANK MB 512919

Coloniae effusae, tenues, pallide vel modice brunneae, villosae. Mycelio immersum. Hyphis ramosae, brunneae. Stroma, setae et hyphopodiis nullis. Conidiophora macronemata, mononemata, erecta, plerumque flexuosa, sparse septata, hyalina vel subhyalina. Cellulae conidiogenae integratae, acroauxicae, monoblasticae integratis, cylindraceus, hyalino-subhyalino. Conidiis solitaria, sicca, acrogena et acropleurogena, doliiformis vel obpyriformis, rostratis, dictyoseptatis, apiculatus, modice vel atro-brunnea, apice et basi hyalino vel pallide brunnea.

SPECIES TYPICA: *Manoharachariella lignicola* Bagyan., N.K.Rao & Kunwar

ETYMOLOGY: The new genus is named in honour of an eminent and reputed mycologist of India, Prof. C. Manoharachary, Department of Botany, Osmania University, Hyderabad, India.

Colonies effuse, thin, pale brown to mid brown, hairy, mycelium immersed, hyphae brown, smooth. Stroma none, setae and hyphopodia absent. Conidiophores macronematous, mononematous, sparsely branched, branches loosely fasciculate, arising laterally and apically from the immersed mycelium, erect, usually flexuous, septate, septa few, hyaline to sub-hyaline. Conidiogenous cells acroauxic, monoblastic, integrated, cylindrical, hyaline to sub-hyaline. Conidia solitary, dry, acrogenous and acropleurogenous, simple, doliiform, obpyriform, ellipsoidal, apiculate, smooth, dictyoseptate, tiered, mid brown to dark brown to blackish brown, apical and basal tiers hyaline to subhyaline.

Manoharachariella lignicola Bagyan., N.K. Rao & Kunwar sp. nov.

FIGS. 1, 2

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Hyphae dense, aggregatae, subepidermalis, 3–4.5 µm lata. Conidiophora usque 35 µm longa, et 3–4.5 µm lata. Conidia 42.5–50.5 µm longa, 25–32 µm in medio saepe, atro-nigro-brunnea, septis obscurae, cellulae apicalis unicellularibus, 3.2–5.5 µm longis.

HOLOTYPE: On unidentified twigs, Darakonda, Distt. Visakhapatnam, A.P., India, 3 Nov 1984, leg. N.K. Rao, IMI 296857.

ETYMOLOGY: The fungus colonized unidentified dead twigs hence lignicola.

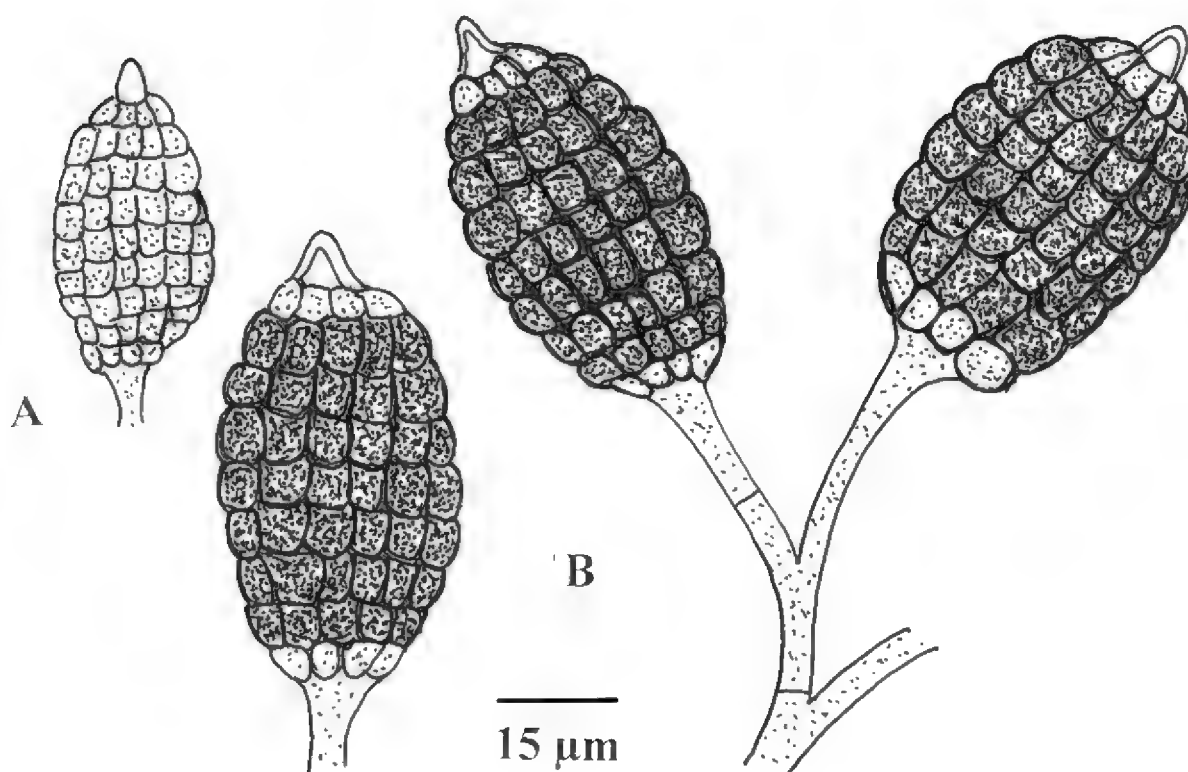


FIG. 1. *Manoharachariella lignicola*. A. Young conidium. B. Mature conidia and conidiophore.

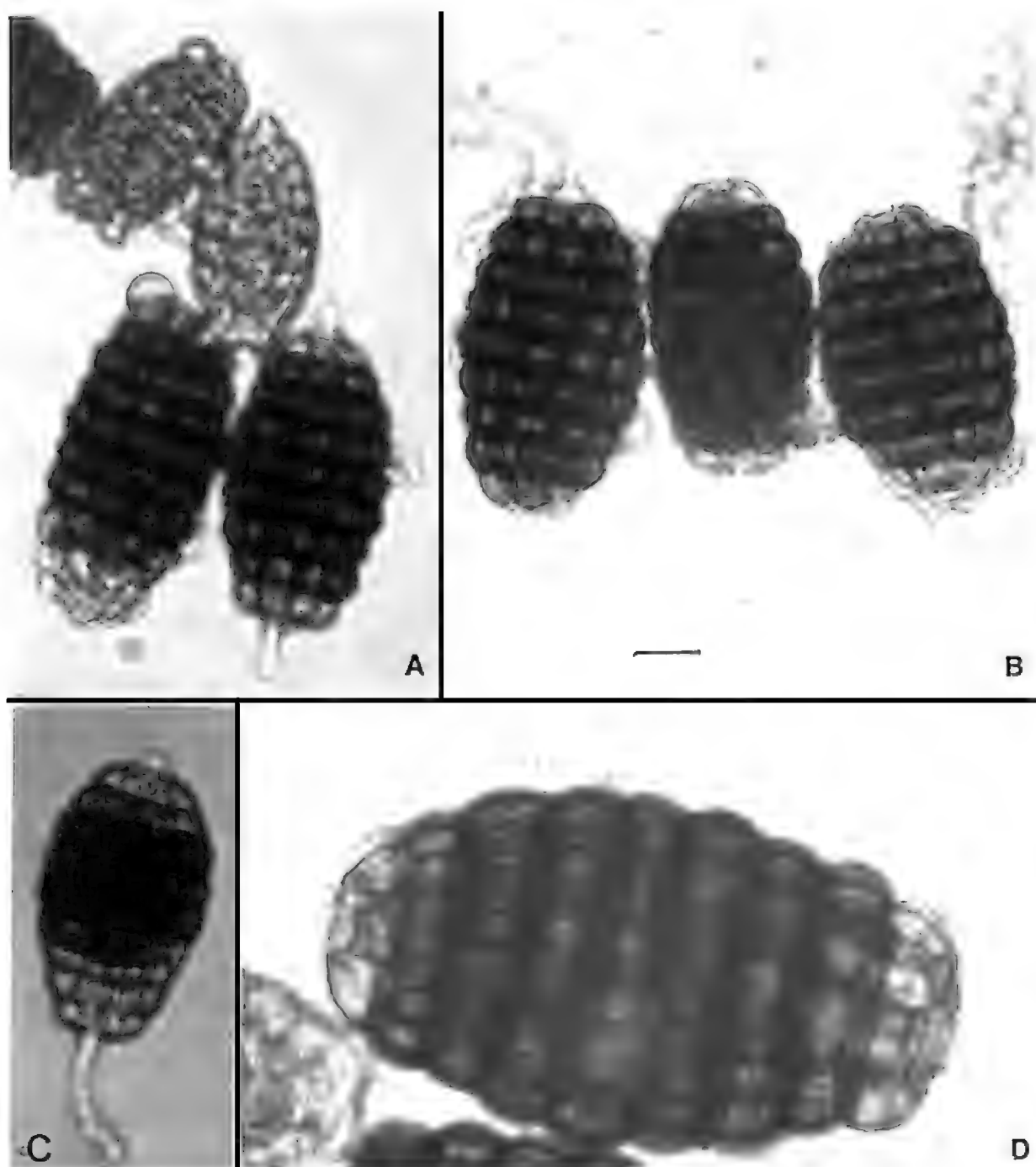


FIG. 2. *Manoharachariella lignicola*. A-C. Bar = 10 μ m. D. Bar = 5 μ m.

Colonies effuse, thin, pale brown to mid brown, hairy, spreading to few millimeters on the host substratum. Mycelium immersed, composed of groups of brown, branched, smooth, 3–4.5 μ m thick hyphae present in the subepidermal region of the host substrate. Conidiophores macronematous, mononematous, sparsely branched, branches loosely fasciculate arising both laterally and apically from the immersed hyphal cells, erect, usually flexuous, septate, septa few, 1–3, hyaline, to sub-hyaline, up to 35 μ m long and 3–4.5 μ m thick. Conidiogenous cells monoblastic, integrated, indeterminate, terminal and lateral, cylindrical, hyaline to sub-hyaline, 2.5–3.5 μ m long. Conidia solitary, dry, acrogenous and acropleurogenous, simple, doliiform, obpyriform,

ellipsoidal, apiculate, dictyoseptate, smooth, tiered, transverse septa 7–9, several longitudinal septa, young conidia uniform in colour, sub-hyaline to pale brown, mature conidia mid-brown to dark brown except 1–2 tier of cells at the apical and basal region which are sub-hyaline to pale brown, middle part of the conidium often dark blackish brown almost obscuring the septation, apiculus one celled, thick walled, hyaline to sub hyaline, 3.2–5.5 μm long, 3.5–5.5 μm wide, conidia 42.5–50.5 μm long, 25–32 μm wide at the broadest part.

The genus, *Manoharachariella* shows some resemblance with *Septosporium* Corda in general and with *Septosporium rostratum* M.B. Ellis (Ellis 1961) in particular in having dictyoseptate, beaked conidia but differs from them in the absence of setae, unbranched conidiophores and percurrent conidiogenous cells. It also shows resemblance in shape with *Xenosporium africanum* Piroz. (Deighton & Pirozynski 1966) and *X. boivinii* S. Hughes (Hughes 1978) but differs from them in producing monoblastic, acrogenous/acropleurogenous, obpyriform, apiculate, smooth and dictyoseptate conidia which are transverse and longitudinally septate. It also differs from *Xenosporium* Penz. & Sacc. in the absence of secondary conidia.

Manoharachariella is comparable with *Bioconiosporium* Bat. & J.L. Bezerra (Ellis 1976) in having solitary, dry, acropleurogenous, doliiform, dictyoseptate conidia, but differs from it in conidia being monoblastic with a single beak, whereas two protuberances are present in *Bioconiosporium*. *Manoharachariella* is slightly comparable to *Monodictys* S. Hughes (Ellis 1971) in having dictyoseptate, monoblastic, dry, acrogenous conidia but differs from it in conidia being apiculate and tiered. There is no other fungus that can accommodate the newly proposed taxon. The present fungus is unique in having effuse, thin colonies, immersed mycelium, sparsely branched conidiophores; monoblastic, acroauxic conidiogenous cells; doliiform, dictyoseptate, tiered, brown to dark brown, apiculate conidia having 1–2 tier of hyaline or sub hyaline cells at the apical and basal end. Hence it is proposed as *Manoharachariella* gen. nov.

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Literature cited

- Castaneda Ruiz RF. 1986. Deuteromycotina de Cuba Hyphomycetes – IV. Academia de Ciencias de Cuba. pp. 17.
- Carmichael JW, Kendrick WB, Connors IL, Sigler L. 1980. Genera of Hyphomycetes. Univ. Alberta Press. 386 pp.
- Deighton FC, Pirozynski KA. 1966. Microfungi II. Mycol. Pap. 105: 1–35.
- Ellis MB. 1961. Dematiaceous Hyphomycetes. III. Mycol. Pap. 79: 3–5.
- Ellis MB. 1971. Dematiaceous Hyphomycetes, CMI, Kew, UK. 608 pp.
- Ellis MB. 1976. More Dematiaceous Hyphomycetes. CMI, Kew, UK. 507 pp.
- Hughes SJ. 1978. New Zealand Fungi. 25. Miscellaneous species. N. Z. J. Bot. 16(3): 311–370.
- Matsushima T. 1975. Icones microfungorum, a Matsushima lectorum, Publ. by the author, Kobe, Japan. 209 pp.
- Matsushima T. 1983. Matsushima Mycological Memoirs. 3: 1–90.
- Matsushima T. 1996. Matsushima Mycological Memoirs. 9: 1–40.
- Mercado-Sierra Á. 1984. Hifomicetes demáciaceos de Sierra del Rosario, Cuba, La Habana, Cuba: Editorial Academia. 181 pp.
- Mercado-Sierra Á, Holubova-Jechova C, Mena Portales J. 1997. Hifomicetes Demaciáceos de Cuba. Enteroblásticos, Museo Regionale di Scienze Naturali, Torino. 388 pp.
- Vasanth Rao, de Hoog GS. 1986. New or critical hyphomycetes from India. Studies in Mycology. 28: 1–84.

***Oxyporus piceicola* sp. nov.
with a key to species of the genus in China**

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Abstract — *Oxyporus piceicola* is new to science, and it is described, illustrated and compared with similar species in this paper. It differs from other species in the genus in its annual and resupinate basidiocarps, thick-walled and apically encrusted cystidia, distinctly ellipsoid and thin-walled basidiospores, and in its growth on *Picea* exclusively. Fifteen polypores of *Oxyporus* have been found in China, and a key to the Chinese species of *Oxyporus* is provided with a statistical variation of spore dimensions.

Key words — *Basidiomycota*, lignicolous and poroid fungi, taxonomy

Introduction

Oxyporus (Bourdot & Galzin) Donk is characterized by having white or cream-coloured tubes, a monomitic hyphal structure with simple septate and cyanophilous generative hyphae, presence of cystidia in most species. Basidiospores in the genus are hyaline, thin- to slightly thick-walled, negative in both Melzer's reagent and Cotton Blue, and all species in the genus cause a white rot (Gilbertson & Ryvarden 1987, Núñez & Ryvarden 2001, Ryvarden & Gilbertson 1994).

Diversity of poroid fungi has been investigated intensively from western China recently (Cui et al. 2008, Dai & Yang 2008, Dai et al. 2007a,b,c, 2008). During a survey of the wood-rotting fungi in this area, two specimens of a polypore collected on stump of *Picea* showed morphology not described before. The basidiocarps are annual and resupinate, have abundant thick-walled and apically encrusted cystidia and a monomitic hyphal structure with

simple septate generative hyphae. The basidiospores are distinctly ellipsoid, hyaline and thin-walled. These characters suggest it as a new species in the genus *Oxyporus*.

Materials and methods

The studied specimens are deposited at the herbarium of Beijing Forestry University (BJFC), and the herbarium of Institute of Applied Ecology, Chinese Academy of Sciences (IFP). Sections were studied at magnification up to $\times 1000$ by using a Nikon Eclipse E80i microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. The microscopic routine used in the study is as presented by Cui et al. (2009). Microscopic features, measurements, and drawings were made from slide preparations stained with Cotton Blue and Melzer's reagent. Spores were measured from sections cut of the tubes. In presenting the variation in the size of the spores, 5% of measurements were excluded from each end of the range and were given in parentheses. In the text the following abbreviations are used: IKI = Melzer's reagent, IKI- = negative in Melzer's reagent, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous, CB- = acyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = variation in the L/W ratios between the specimens studied, n = number of spores measured from given number of specimens. Special colour terms follow Petersen (1996) and Anonymous (1969).

Description

Oxyporus piceicola B.K. Cui & Y.C. Dai, sp. nov.

FIG. 1

MYCOBANK MB 513407

Carpophorum annuum, resupinatum, contextum cremeum. Facies pororum crenea vel mellea; pori rotundi, 4–6 per mm. Systema hypharum monomiticum, hyphae septatae sine fibulis, hyphae subiculi 2.5–4.5 μm in diam. Cystidia clavata, incrustata, Sporae pallidae, ellipsoideae, 4.6–5.3 \times 3–3.6 μm .

TYPE. — China. Qinghai Prov., Huzhu County, Beishan Forest Park, on stump of *Picea*, 31.VIII.2003 Dai 5033 (holotype in IFP, isotype in BJFC).

ETYMOLOGY — *piceicola* (Lat.): referring to the tree genus *Picea*.

FRUITBODY — Basidiocarps annual, resupinate, soft corky to fragile when dry, pore surface cream to cinnamon buff when dry, up to 3 m long, 2 cm wide, and 1 mm thick. Sterile margin narrow, pale cream, up to 1 mm wide. Pores round, 4–6 per mm, dissepiments thin, lacerate. Subiculum very thin to almost lacking, less than 0.1 mm thick, cream and soft corky when dry. Tube layer concolorous with pore surface, brittle when dry, tubes up to 0.9 mm long.

HYPHAL STRUCTURE — Hyphal system monomitic, hyphae simple septate, IKI-, CB+, tissue unchanged in KOH.

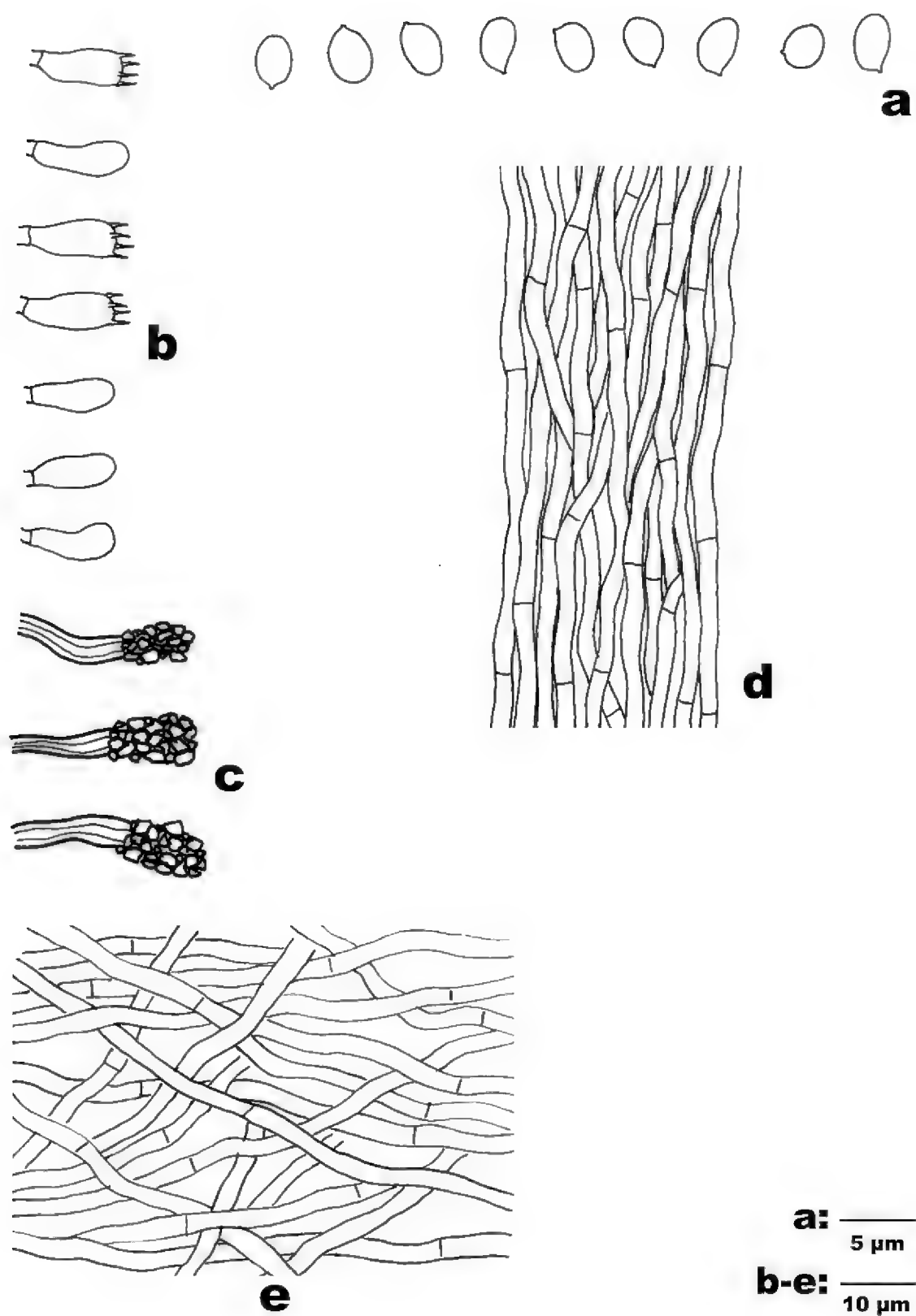


FIG. 1. Microscopic structures of *Oxyporus piceicola* (drawn from the holotype).
—a: Basidiospores. —b: Basidia and basidioles. —c: Cystidia.
—d: Hyphae from tube. —e: Hyphae from subiculum.

SUBICULUM — Subicular hyphae hyaline, thin- to slightly thick-walled with a wide lumen, frequently simple septate, occasionally branched, more or less flexuous, loosely interwoven, 2.5–4.5 μm in diam.

TUBES — Tramal hyphae hyaline, thin- to slightly thick-walled with a wide lumen, frequently simple septate, rarely branched, more or less straight, subparallel along the tubes, usually covered by irregular crystals, 2–4 µm in diam. Cystidia present, clavate, thin- to thick-walled, apically encrusted, arising from tramal hyphae, 30–48 × 5–7 µm. Basidia clavate, with four sterigmata and a basal simple septum, 13–22 × 5–6 µm, basidioles mostly barrel-shaped, slightly smaller than basidia.

SPORES — Basidiospores ellipsoid, hyaline, thin-walled, smooth, usually bearing a small guttule, IKI–, CB–, (4.5–)4.6–5.3(–5.5) × (2.9–)3–3.6(–3.7) µm, L=4.95 µm, W=3.27 µm, Q=1.5–1.53 (n=90/3).

ADDITIONAL SPECIMEN EXAMINED — China. Sichuan Prov., Jiuzhaigou County, Huanglong Nature Reserve, on stump of *Picea*, 15.X.2002 Dai 4232 (IFP, BJFC).

TYPE OF ROT — White rot.

Discussion

Oxyporus piceicola is characterized by annual and resupinate basidiocarps, thick-walled and apically encrusted cystidia, distinctly ellipsoid and thin-walled basidiospores, and by exclusive growth on *Picea*. *Oxyporus subpopulinus* B.K. Cui & Y.C. Dai, also described from western China and found on *Picea*, is distinguished from *O. piceicola* in having perennial basidiocarps and smaller (3.4–4.7 × 2.3–3.2 µm) basidiospores (Cui et al. 2006).

Oxyporus obducens (Pers.) Donk has annual and resupinate basidiocarps, similar pores (4–6 per mm), abundant thick-walled and encrusted cystidia, and ellipsoid basidiospores. However, it grows on angiosperm wood, and its basidiospores are less than 4.6 µm in length.

Oxyporus corticola (Fr.) Ryvarden, which has resupinate basidiocarps and may grow on *Picea*, differs from *O. piceicola* in having larger (2–4 per mm) pores and bigger (5–7 × 3–4.5 µm) basidiospores (Núñez & Ryvarden 2001).

Thirteen species of *Oxyporus* were reported from China previously (Zhao & Zhang 1992, Dai 1998, Dai et al. 2004, Dai & Wang 2005, Yu et al. 2005, Cui et al. 2006). The diagnostic key to Chinese *Oxyporus* species given below provides statistical variations of spore dimensions for each species.

Key to species of *Oxyporus* in China

(spore dimensions are given after species names)

- 1. Pore surface yellowish, spores cylindrical *O. cervinogilvus* (Jungh.) Ryvarden
(5.8–)6.1–7.3(–9) × (2.8–)3–3.5(–3.6) µm,
L=6.89 µm, W=3.09 µm, Q=2.12–2.25 (n=60/2)
- 1. Pores surface white or cream, spores ellipsoid or subglobose 2
- 2. Basidiocarps distinctly pileate 3
- 2. Basidiocarps resupinate 7

3. Cystidia thin-walled, arising from subhymenium, contextual hyphae rarely septate
..... *O. bucholtzii* (Bondartsev & Ljub.) Y.C. Dai & Niemelä
(4–)5.2–6.2(–6.5) × (3–)3.5–4.1(–4.5) µm,
L=5.68 µm, W=3.9 µm, Q=1.47–1.48 (n=60/2)
3. Cystidia thick-walled, originating from trama, contextual hyphae frequently
septate 4
4. Basidiocarps annual, pores 3–4 per mm *O. cuneatus* (Murrill) Aoshima
(3.7–)4–4.8(–5) × (2.7–)2.9–3.7(–4) µm,
L=4.21 µm, W=3.19 µm, Q=1.26–1.38 (n=60/2)
4. Basidiocarps perennial, pores 4–8 per mm 5
5. Pores 4–5 per mm, spores > 5 µm in length *O. sinensis* X.L. Zeng
(4.7–)5.2–6.6(–7) × (3.8–)4–5(–6) µm,
L=5.89 µm, W=4.54 µm, Q=1.25–1.36 (n=120/4)
5. Pores 5–8 per mm, spores < 5 µm in length 6
6. Spores subglobose, grow mostly on *Acer* *O. populinus* (Schumach.) Donk
(3–)3.3–4.3(–4.4) × (2.9–)3–3.7(–3.9) µm,
L=3.79 µm, W=3.29 µm, Q=1.14–1.17 (n=98/3)
6. Spores ellipsoid, grow mostly on *Picea* *O. subpopulinus*
(3–)3.4–4.7(–5) × (2.1–)2.3–3.2(–3.5) µm,
L = 3.92 µm, W = 2.88 µm, Q = 1.32–1.41 (n=180/6)
7. Cystidia absent *O. ginkgonis* Y.C. Dai
(4.8–)4.9–6(–6.5) × (3.9–)4.1–5(–5.2) µm,
L=5.3 µm, W=4.57 µm, Q=1.08–1.22 (n=90/3)
7. Cystidia present 8
8. Basidiocarps perennial, basidiospores > 7 µm in length
..... *O. macroporus* Y.C. Dai & Y.L. Wei
(6.2–)7–8(–9) × (3.4–)3.5–4.1(–4.2) µm,
L=7.37 µm, W=3.85 µm, Q=1.92 (n=30/1)
8. Basidiocarps annual, basidiospores < 7 µm in length 9
9. Cystidia subulate *O. subulatus* Ryvarden
(4.1–)4.3–5(–5.1) × (2.4–)2.5–3.2(–3.3) µm,
L=4.58 µm, W=2.78 µm, Q=1.58–1.72 (n=60/2)
9. Cystidia clavate 10
10. Pores 4–6 per mm, hyphoid cystidia arising from trama 11
10. Pores 1–4 per mm, hymenial cystidia originating from subhymenium 12
11. On angiosperm wood; basidiospores < 4.6 µm in length *O. obducens*
(3.3–)3.5–4.6(–5) × (2.5–)2.7–3.5(–3.8) µm,
L=4.08 µm, W=3.1 µm, Q=1.26–1.38 (n=60/2)
11. On gymnosperm wood; basidiospores > 4.6 µm in length *O. piceicola*
(4.5–)4.6–5.3(–5.5) × (2.9–)3–3.6(–3.7) µm,
L=4.95 µm, W=3.27 µm, Q=1.5–1.53 (n=60/2)
12. Spores subglobose 13
12. Spores broadly ellipsoid 14

13. On gymnosperm; spores $< 4 \mu\text{m}$ in width *O. cuneatus*
 $(3.7-4-4.8(-5) \times (2.7-2.9-3.7(-4) \mu\text{m},$
 $L=4.21 \mu\text{m}, W=3.19 \mu\text{m}, Q=1.26-1.38 (n=60/2)$
13. On angiosperm; spores $> 4 \mu\text{m}$ in width *O. philadelphi* (Parmasto) Ryvarden
 $(4.6-4.8-5.2(-5.3) \times (3.7-3.8-4.8(-4.9) \mu\text{m},$
 $L=5.01 \mu\text{m}, W=4.39 \mu\text{m}, Q=1.14 (n=30/1)$
14. Encrusted and smooth cystidia present, subicular hyphae $3-5 \mu\text{m}$ in diam
..... *O. corticola*
 $(4.5-4.9-6.2(-7) \times (2.9-3-4(-4.1) \mu\text{m},$
 $L=5.53 \mu\text{m}, W=3.37 \mu\text{m}, Q=1.60-1.74 (n=120/4)$
14. Only encrusted cystidia present, subicular hyphae $5-7 \mu\text{m}$ in diam
..... *O. latemarginatus* (Durieu & Mont.) Donk
 $(4.8-5-8.5(-9) \times (2.9-3-3.7(-4) \mu\text{m},$
 $L=5.76 \mu\text{m}, W=3.31 \mu\text{m}, Q=1.65-1.79 (n=60/2)$

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Literature cited

- Anonymous, 1969. Flora of British fungi. Colour identification chart. Her Majesty's Stationery Office, London
- Cui BK, Huang MY, Dai YC. 2006. A new species of *Oxyporus* (Basidiomycota) from western China. Mycotaxon 96: 207–210.
- Cui BK, Dai YC, Li BD. 2009. Notes on the genus *Rigidoporus* (Basidiomycota, Polyporaceae) in China. Nova Hedwigia 88: 189–197.
- Cui BK, Wang Z, Dai YC. 2008. *Albatrellus piceiphilus* sp. nov. on the basis of morphological and molecular characters. Fungal Diversity: 28: 41–48.
- Dai YC. 1998. Changbai wood-rotting fungi 9. Three new species and other species in *Rigidoporus*, *Skeletocutis* and *Wolfiporia* (Basidiomycota, Aphyllophorales). Annales Botanici Fennici 35: 143–154.
- Dai YC, Cui BK, Decock C. 2008. A new species of *Fomitiporia* (Hymenochaetaceae, Basidiomycota) from China based on morphological and molecular characters. Mycological Research, 112: 375–380.
- Dai YC, Cui BK, Yuan HS. 2007a. Notes on polypores from Gansu and Qinghai Province, northwest China. Cryptogamie Mycologie 28: 177–187.
- Dai YC, Cui BK, Yuan HS, Li BD. 2007b. Pathogenic wood-decaying fungi in China Forest Pathology 37: 105–120.
- Dai YC, Wang Z. 2005. A new polypore on *Ginkgo* from China. Mycotaxon 92: 345–349.

- Dai YC, Wei YL, Wang Z. 2004. Wood-inhabiting fungi in southern China 2. Polypores from Sichuan Province. *Annales Botanici Fennici* 41: 319–329.
- Dai YC, Wei YL, Yuan HS, Huang MY, Penzina T. 2007c. Polypores from Altay and Tian Mts. in Xinjiang, northwest China. *Cryptogamie Mycologie* 28: 269–279.
- Dai YC, Yang F. 2008. A new species of *Phellinus* (*Basidiomycota*, *Hymenochaetales*) from western China. *Mycotaxon* 104: 103–106.
- Gilbertson RL, Ryvarden L. 1987. North American polypores 2. *Megasporoporia* - *Wrightoporia*. *Fungiflora*, Oslo. pp. 434–885.
- Núñez M, Ryvarden L. 2001. East Asian polypores 2. *Polyporaceae s. lato*. *Syn. Fungorum* 14: 165–522.
- Petersen JH. 1996. Farvekort. The Danish Mycological Society's colour-chart. Foreningen til Svampekundskabens Fremme, Greve.
- Ryvarden L, Gilbertson RL. 1994. European polypores 2. *Syn. Fungorum* 7: 394–743.
- Yu CJ, Zuo L, Dai YC. 2005. Three polypores from Xizang new to China. *Fungal Science* 20: 61–68.
- Zhao JD, Zhang XQ. 1992. The polypores of China. *Bibliotheca Mycologica* 145: 1–524.

On the identity of Velenovský's *Cantharellus peltigerae*

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Abstract — The application of the name *Cantharellus peltigerae*, which was introduced by Velenovský in 1920 (not 1922 as commonly cited), has been uncertain. A spirit bottle containing original material has now been located in PRC, and found to contain two species of *Arrhenia*, *A. peltigerina* and *A. cfr. griseopallida*. The first grows on old thalli of *Peltigera* species, and the second on soil. The element on *Peltigera* is designated as lectotype here to fix Velenovský's name as a later taxonomic synonym of *A. peltigerina*. Original material of *Mycena praecox*, also described by Velenovský in 1920, was said to be present in the same spirit bottle, but no *Mycena* was to be found inside.

Key words — agaric, *Basidiomycota*, lectotypification, lichenicolous fungi

Introduction

While browsing through Pilát's (1948) compilation and Latin translation of the new taxa of Velenovský's České Houby during an interlude at a meeting of the Governing Committee of the European Mycological Association in Prague in January 2005, the attention of one of us (D.L.H.) was caught by an entry for *Cantharellus peltigerae*. This name was first published by Velenovský (1920a: 270), although it is cited only from a later publication (Velenovský 1922: 911) by both Petrak (1929: 332) and Pilát (1948: 16). Both Velenovský's accounts are in Czech. In the monograph of cantharelloid fungi by Corner (1966), this name only featured in the index (op. cit.: 250) as "(1922), incert. sed." with no discussion or mention in the main text of the work. Although the mushroom

was stated to grow on old thalli of *Peltigera*, the name is not treated in the principle works on lichenicolous fungi (i.e. Vouaux 1912–14, Keissler 1930, Clauzade et al. 1989). The name was, however, mentioned in the catalogue of the lichenicolous of the Czech Republic by Kocourková (2000: 140) who reported that Z. Pouzar had examined a Czech specimen collected in 1930 by Pilát kept under this name (PRM 655552); in this the basidiomes arose from plant debris under a *Peltigera* thallus, and Pouzar asserted that “the fungus does not belong to *Cantharellus*” and that the type material in PRC needed to be studied.

Suspecting from Pilát’s Latin description that this might represent the species known as *Arrhenia peltigerina*, at the request of D.L.H., J.K. managed to locate the original material on which this name was based in a preservative liquid in a polythene bottle in the collections of Charles University (Universitatis Carolinae) in Prague (PRC). This note reports the results of our examination of this material and fixes its application.

Taxonomy

Cantharellus peltigerae Velen., Věda Přírodní 1: 270 (1920).

TYPE: CZECH REPUBLIC: Prague, Chuchle, on old thalli of *Peltigera* sp., April 1910, O. Reisner (PRC 336[a] [parte cum *Peltigera*] – *lectotypus hic designatus*).

= *Arrhenia peltigerina* (Peck) Redhead et al., Mycotaxon 83: 48 (2002).

= *Agaricus peltigerinus* Peck, Ann. Rep. N. Y. St. Mus. Nat. Hist. 30: 38 (1878) [“1876”].

No dried type or authentic material under Velenovský’s name could be located in PRC and PRM, and the only material he evidently preserved was that in spirit now maintained in PRC in a polythene bottle numbered 336. This bottle was also listed in <http://katalogy.nmcz/opac/houby/index.php> as containing material of *Mycena praecox*, a species described as new by Velenovský (1920b: 325). However, there is actually a second bottle numbered as “336b” labeled as *M. praecox* so we presume that labeled “336” should be “336a”.

Velenovský (1920a) mentioned four sites for the species in what is now the Czech Republic, all in groups on old *Peltigera* thalli: (a) Prague, Chuchle, April 1910, O. Reisner; (b) Prague, Hvězda, April, O. Zvěřinová; (c) Jince–Zdice, April, F.A. Novák; and (d) near Habr at Říčany, May 1920, J. Velenovský. According to a label of Velenovský’s glued to the card file, the specimen in PRC 336a is from “Chuchle, iv.1920” with no data as to the collector. No other information to link the numerous small mushrooms in the bottle to particular sites was found. We separated the individual specimens onto filter paper, examined them by routine microscopical methods, and found that there were two species present. One was growing directly on and firmly attached to aged *Peltigera* thallus fragments (most probably of *P. rufescens*), and the other arose directly from soil between mosses. We assume that the one on the *Peltigera* is that from Chuchle, and that “1910” was mistranscribed as “1920” on the index card.

The material on the *Peltigera* agreed in all habit and microscopical details we were able to measure, with *Arrhenia peltigerina* (Garnier-Delcourt 2008, Barrasa & Rico unpubl.). Thus, the studied specimens of *A. peltigerina* (PRC 336[a] p.p.; i.e. the parts on *Peltigera*) have: both intracellular and slightly extracellular encrusted pigment in the hyphae of the pileipellis; spores that are non-amyloid, ellipsoid, apiculate, and $8-9 \times 4.5-6 \mu\text{m}$; basidia that are 4-spored, $30-35 \times 5-6 \mu\text{m}$; and clamp connections in all tissues.

The specimens apparently arising directly from soil, however, were poorly preserved, but some microscopic details could be determined. This species had: clamp connections, a zebroid encrusted pigment in the pileipellis, spores that were non-amyloid, ellipsoid to pyriform or sublacrymoid measuring $9-11 \times 6-6.5 \mu\text{m}$; and 2-4-spored basidia. These features show that this is a different *Arrhenia* species, most likely *A. griseopallida* (Desm.) Watling 1989 (cfr. Kuyper 1995: 86, as *Omphalina griseopallida*). That species is considered to be a saprobe and not lichenicolous or lichenized; reports of its being associated with algae (e.g. Hawksworth 1972) are likely to be mis-identifications for species of *Lichenomphalia*.

No evidence of any *Mycena* was found in PRC 336[a] nor was any *Mycena* found in PRC 336b by Kubičková in 1978 according to a revision label, the database, and a card file in PRC; there is, however, no evidence that she studied bottle PRC 336[a]. We speculated whether the *A. cfr. griseopallida* might have been what Velenovský (1920b: 325) described as the new species *M. praecox*, but there are important differences from the protologue. In particular, it occurred on wet parts of trunks and stumps of deciduous trees, the pileus recalled a long blunt truncated cone, which was black-grey with translucent lamellae when wet and also 2 cm wide, and cystidia and coralloid hyphae were very common in the pileipellis. No cystidia or coralloid hyphae whatever occur in *Arrhenia* species. This *Mycena* was compared and then synonymized with *M. abramsii* (Murrill) Murrill 1916 by Maas Geesteranus (1980: 167), but only on the basis of the published description, as he did not locate any original material. Superb colour macro- and microscopic illustrations of *M. abramsii* are provided by Robich (2007: 217–222). We can only conclude that the original material of *M. praecox* in PRC 336 had been removed from the bottle and separated out as PRC 336b subsequent to its original labeling, and then lost or destroyed.

As all four of the specimens of *Cantharellus peltigerae* cited by Velenovský (1920a, 1922) were growing on (not between) *Peltigera* thalli and as their features agree closely with his descriptions, we treat this name as a later taxonomic synonym of *A. peltigerina* and here lectotypify it by the basidiomes on the *Peltigera* thalli in PRC 336[a], which we assume to have been the syntype from “Chuchle” with the year of collection wrongly transcribed on the label glued to the index card.

How material of *A. cfr. griseopallida* came to be in the same spirit bottle as the *Cantharellus peltigerae* material and what became of that of *Mycena praecox* are two mysteries that must remain unsolved at this time. In the light of this experience, we do, however, strongly recommend that type and authentic or other key material of mushrooms be preserved as dried herbarium specimens where they can be kept in well-labeled packets – and not several together (or even singly) in spirit in bottles bearing only a reference number.

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Literature cited

- Clauzade G, Diederich P, Roux C. 1989. Nelikeniĝintaj fungoj likenloĝaj: ilustrita determinilibro. Bulletin de la Société linnéenne de Provence, numéro special 1: 1–142.
- Corner E.J.H. 1966. A Monograph of Cantharelloid Fungi. [Annals of Botany Memoirs No. 2.] Oxford University Press: Oxford. 255 pp.
- Garnier-Delcourt M. 2008. *Arrhenia peltigerina*, un basidiomycète lichénicole nouveau pour la mycoflore luxembourgeoise (*Basidiomycota*, *Agaricales*, *Tricholomataceae*. Bulletin Société des Naturalistes Luxembourgeois 109: 3–7.
- Hawksworth DL. 1972. The natural history of Slapton Ley Nature Reserve IV. Lichens. Field Studies 4: 535–578.
- Keissler KA. 1930. Flechtenparasiten. Dr L. Rabenhorst's Kryptogamen-Flora von Deutschland, Österreich und der Schweiz 8: i–ix, 1–712.
- Kocourková J. 2000. Lichenicolous fungi of the Czech Republic (the first commented checklist). Acta Musei Nationalis Pragae, Series B, Historia Naturalis 55: 59–169.
- Kuyper TW. 1995. *Omphalina* Quél. In: Bas C, Kuyper TW, Noordeloos ME, Vellinga EC (eds), Flora Agaricina Neerlandica. Vol. 3. Rotterdam: A.A.Balkema, pp. 78–88.
- Maas Geesteranus RA. 1980. Studies in *Mycena* 1–4. Proceedings, Koninklijke Nederlandse Akademie van Wetenschappen C 83: 167–174.
- Petrak F. 1929. XII. Verzeichnis der neuen Arten, Varietäten, Formen, Namen und wichtigsten Synonyme der Pilze 1922–1928. Just's Botanischer Jahresbericht 57: 291–697.
- Pilát A. 1948. Velenovskýi species novae basidiomycetum. [Opera Botanica Čechica No.6.] Societas Botanica Českoslovaca: Prague. 301 pp.
- Robich G. 2007. *Mycena* d'Europa. Associazione Micologica de Bresadola: Trento. 728 pp.
- Velenovský J. 1920a. Různé zprávy mykologické. Věda Přírodní 1: 270–271.
- Velenovský J. 1920b. České Houby. Vols 1–2. Česká Botanická Společnost: Prague. 424 pp.
- Velenovský J. 1922. České Houby. Vols 4–5. Česká Botanická Společnost: Prague. 217 pp.
- Vouaux L. 1912–14. Synopsis des champignons parasites de lichens. Bulletin de la Société Mycologique de France 28: 177–256; 29: 33–128, 399–494; 30: 135–198, 281–329.

***Ocellularia gyrostromoides* belongs to the genus *Schizoxylon* (*Stictidaceae*, *Ascomycota*)**

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Abstract — While revising thelotrematoid *Graphidaceae* in Australia, we studied the type specimen of *Ocellularia gyrostromoides* and found it to be a non-lichenized fungus belonging to *Stictidaceae*. Here we report that the species belongs to the genus *Schizoxylon* (*Stictidaceae*) and propose the new combination *Schizoxylon gyrostromoides*.

Key words — *Ostropales*, taxonomy, *Thelotremataceae*

Introduction

While revising thelotrematoid *Graphidaceae* in Australia (Mangold et al. 2009) we also studied the type of *Ocellularia gyrostromoides*, which is an Australian endemic that has been accepted in the recent checklist of Australian lichens (McCarthy 2006). The name has been used in herbaria for species that are currently placed in *Schizotrema* (Mangold et al. 2009, Rivas Plata et al. 2010). However, examination of the type of *O. gyrostromoides* revealed that the species does not belong to *Graphidaceae* (incl. *Thelotremataceae*) as currently circumscribed (Mangold et al. 2008), but is a non-lichenized fungus belonging to the genus *Schizoxylon* in *Stictidaceae*. The necessary combination is made here and a short description of the fungus is given below.

Material and methods

Hand sections were examined in water and Lugol's solutions using a ZEISS Axioscope 2 plus compound microscope. TLC was performed with solvent

system A and B' (Culberson 1972, Culberson & Johnson 1982). Type material from G was studied and material for comparison that is deposited in F.

The species

Schizoxylon gyrostomoides (Müll. Arg.) Lumbsch & Papong, comb. nov. FIG. 1
MYCOBANK MB 513489

Bas.: *Ocellularia gyrostomoides* Müll. Arg., Flora 71: 46 (1888); type:
Australia, Queensland, Daintree River, *Pentzke* (G, holotype).

APOTHECIA orbicular, at first immersed in the substrate, becoming erumpent, 0.2–0.7 mm diam.; disc urceolate, brown, plane, whitish-pruinose; split between disc and margin obvious, margin prominent, thick, dark grey, smooth, entire. Exciple cupulate, brown, interspersed with numerous large crystals, lateral paraphyses absent. Subhymenium hyaline, 15–20 µm high. Hypothecium brown, 20–25 µm high. Hymenium hyaline, 100–140 µm high, clear to sparsely inspersed with large oil droplets. Epihymenium red-brown, 10 µm high, with crystals; pigmentation dissolving in K. Paraphyses simple to sparingly branched apically, apically not thickened to slightly thickened, hyaline. Asci long-

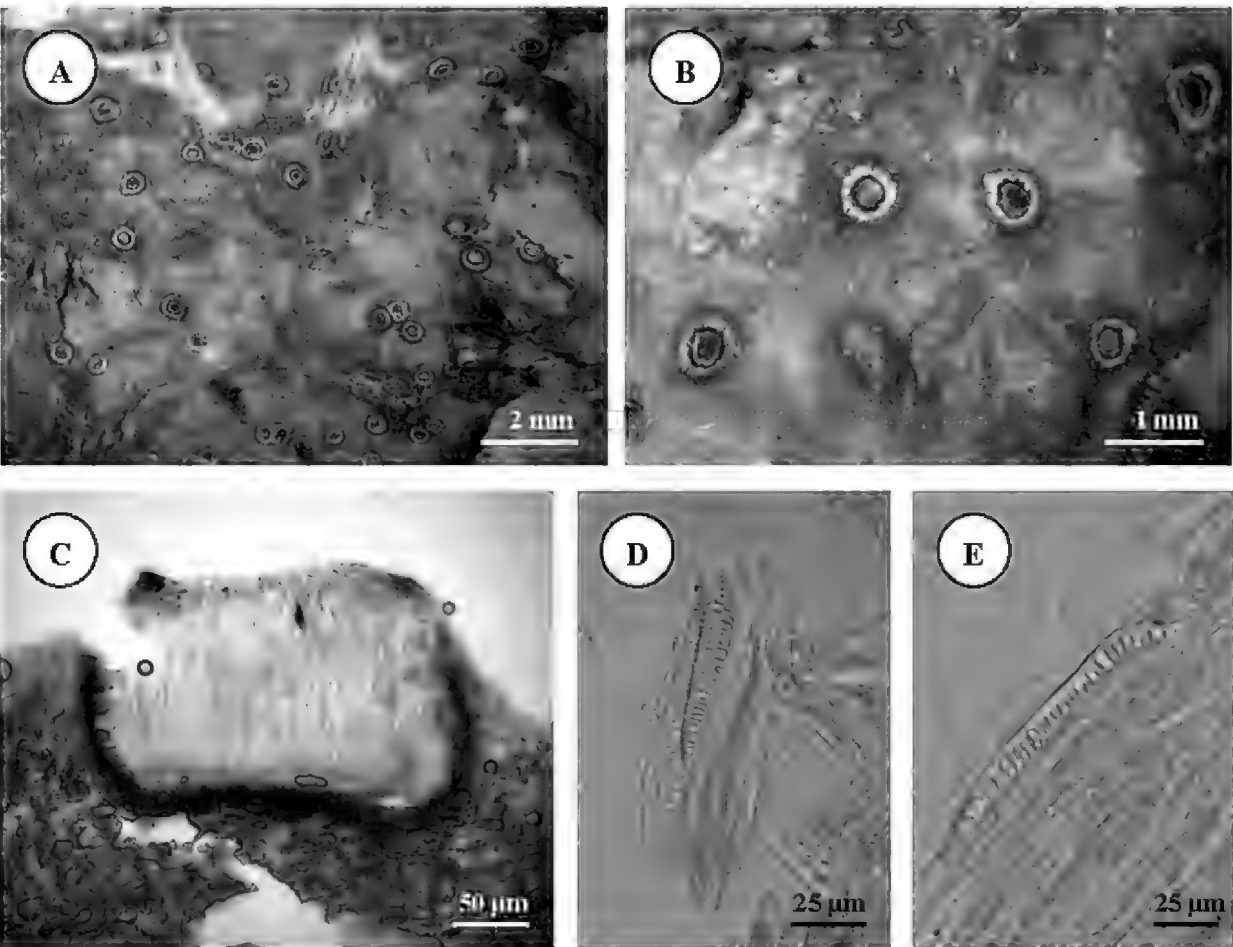


FIGURE 1 *Schizoxylon gyrostomoides*, holotype (G) (A) Habitat; (B) Habit detail, showing urceolate ascomata; (C) Cross section through ascoma; (D) Ascus with ascospores; (E) Fusiform ascospores.

cylindrical, 80–120 µm long, 8-spored, I+ faintly blue. Ascospores hyaline, fusiform, transversally septate, with 25–40 loculi, not disarticulating, loculi angular, I–, 45–65 × 5–7.5 µm, cell walls thick. Conidiomata not seen.

CHEMISTRY. No secondary metabolites detected by TLC.

NOTES. The faintly amyloid asci and the structure of the hymenium, exciple and ascospores indicate that this fungus belongs to *Stictidaceae* (Gilenstam 1969; Wedin et al. 2005, 2006). The absence of lateral paraphyses, the presence of abundant crystals in the exciple, and the initially immersed ascomata place this species in the genus *Schizoxylon* (Sherwood 1977a, b). Within *Schizoxylon* this species is characterized by a brown exciple and non-disarticulating ascospores shorter than 100 µm. The most similar species is *S. pseudocyanosporum* Sherwood from pine wood in Pakistan, which, however, is readily distinguished by larger, elongate ascomata and slightly larger ascospores [60–75 µm long].

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Philippe Clerc (Geneva) is thanked for sending the type material on loan for examination. Armin Mangold (Berlin) initially studied the material and suggested it belongs to *Stictidaceae* and not *Thelotremataceae*. John A. Elix (Canberra) and Patrick McCarthy (Canberra) are thanked for reviewing this manuscript. This study was supported by a NSF grant (DEB-0516116) to The Field Museum (PI: HTL) and a grant from Australian Biological Resources Study (ABRS) to HTL.

Literature cited

- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *Journal of Chromatography* 72: 113–125.
- Culberson CF, Johnson A. 1982. Substitution of methyl tert.-butyl ether for diethyl ether in standardized thin-layer chromatographic method for lichen products. *Journal of Chromatography* 238: 438–487.
- Gilenstam G. 1969. Studies in the lichen genus *Conotrema*. *Arkiv för Botanik*, Ser. 2, 7: 149–179.
- Mangold A, Elix JA, Lumbsch HT. 2009. *Thelotremataceae*. *Flora of Australia* 57: 195–420.
- Mangold A, Martin MP, Lücking R, Lumbsch HT. 2008. Molecular phylogeny suggests synonymy of *Thelotremataceae* within *Graphidaceae* (*Ascomycota* : *Ostropales*). *Taxon* 57: 476–486.
- McCarthy PM. 2006. Checklist of the Lichens of Australia and its Island Territories, Australian Biological Resources Study, Canberra. Version 6. April 2006.
- Rivas Plata E, Lücking R, Sipman HJM, Mangold A, Lumbsch HT. 2010. A world-wide key to the thelotrematoid *Graphidaceae*, excluding the *Ocellularia*-*Myriotrema*-*Stegobolus* clade. *Lichenologist* 42: in press.
- Sherwood MA. 1977a. The Ostropalean Fungi. *Mycotaxon* 5: 1–277.
- Sherwood MA. 1977b. The Ostropalean Fungi II: *Schizoxylon*, with notes on *Stictis*, *Acarosporina*, *Coccopeziza*, and *Carestiella*. *Mycotaxon* 6: 215–260.
- Wedin M, Döring H, Gilenstam G. 2006. *Stictis* s. lat. (*Ostropales*, *Ascomycota*) in northern Scandinavia, with a key and notes on morphological variation in relation to lifestyle. *Mycological Research* 110: 773–789.

Wedin M, Döring H, Konberg K, Gilenstam G. 2005. Generic delimitations in the family *Stictidaceae* (*Ostropales*, *Ascomycota*): the *Stictis*-*Conotrema* problem. *Lichenologist* 37: 67–75.

***Roselliniella stereocaulorum* (Sordariales, Ascomycota), a new lichenicolous fungus from the Holarctic**

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Abstract — *Roselliniella stereocaulorum* growing on *Stereocaulon* spp. is described as new from Poland, the Asiatic part of Russia and the USA (Alaska).

Key words — taxonomy, new species

Introduction

Roselliniella Vain. (Sordariales, Ascomycota) is an obligate lichenicolous pyrenomycetous genus that included 15 species. It is characterized mainly by non-amyloid, up to 8-spored asci without distinct apical structures, brown, simple or very rarely septate ascospores with smooth or microguttulate (not verruculose) walls lacking visible pores, and brown, commonly distinct vegetative hyphae penetrating usually only the host tissues, but sometimes also surrounding perithecia (Matzer & Hafellner 1990, Aptroot et al. 1997, Hawksworth & Miądlikowska 1997, Hoffmann & Hafellner 2000, Etayo 2002, Etayo & Sancho 2008). Members of the genus grow mainly on various foliose, fruticose and occasionally also crustose lichens of two orders, *Lecanorales* and *Peltigerales* (Matzer & Hafellner 1990, Aptroot et al. 1997, Hawksworth & Miądlikowska 1997, Etayo 2002), with the exception of *R. microthelia* (Wallr.) Nik. Hoffm. & Hafellner. This species is confined to the genus *Trapelia* M. Choisy (Hoffmann & Hafellner 2000), a member of *Baeomycetales* (classification according to Lumbsch & Huhndorf 2007, Lumbsch et al. 2007).

During the studies on lichenicolous fungi in the Holarctic and a revision of the genus *Stereocaulon* in Poland, we found interesting specimens of *Roselliniella* with predominantly 4-spored asci. It is the first record of a *Roselliniella* growing

on the *Stereocaulaceae* (order *Lecanorales*), and closer examination revealed it represents a so far unknown species. The aim of this paper is to describe the new taxon.

Material and methods

The material was examined by standard microscopic techniques using LOMO microscopes MBS-1, Mikromed-2 and Zeiss microscope Axio Imager A1 equipped with Nomarski differential interference contrast optics. Photographs were taken by AxioCamMR5 cameras. Microscopical measurements were made in water. Color reactions were examined in 10 % KOH (K), 1 % Lugol's iodine solution, directly (I) or after KOH pre-treatment (K/I). The length, breadth and length/breadth ratio (l/b) of asci and ascospores are given as: (min.–){X–SD}–X–{X+SD}(–max.), where min. and max. represent the extreme values, X the arithmetic mean, and SD the standard deviation. The measurements of asci were rounded to the nearest 1 µm, whereas those of the ascospores to the nearest 0.5 µm. Examined specimens are deposited in KTC, LE and UGDA.

Results and discussion

Roselliniella stereocaulorum Zhurb., Kukwa & Oset, sp. nov.

PLATE 1

MYCOBANK MB 513382

Fungus lichenicola in thallis lichenum generis Stereocaulon parasiticus. Similis Roselliniellae cladoniae, sed ascis imprimis 4-sporis, ascosporis levibus, semper non septatis et hospite diverso differt.

TYPUS: USA. Alaska, Great Kobuk Sand Dunes, Ahnewetut Creek, 67°02'N, 158°50'W, alt. 50 m, open lichen heath among sparse *Picea glauca* forest, on *Stereocaulon alpestre* (stems, phyllocladia), 1.VIII.2000, M. Zhurbenko 0045 (LE –210332–holotypus).

ETYMOLOGY: The name refers to the host genus.

DESCRIPTION: VEGETATIVE HYPHAE immersed in the substrate, abundant, flexuose, scarcely branched, smooth-walled, evenly medium brown, septate, of cells 15–30 × 2–5 µm; ASCOMATA perithecioid, dispersed, pyriform, ovate, occasionally subglobose or narrowly ovate, ostiolate, infrequently with a distinct neck, black, rarely with a brown tint, matt, rough, 0.2–0.4 mm wide, 0.3–0.5 mm high, $\frac{3}{4}$ immersed in host tissues to sessile, occasionally almost completely hidden in host's tomentum, occasionally attached laterally, sometimes covered by conspicuous dark hairs, particularly in the lower part; HAIRS more or less straight, unbranched, smooth-walled, evenly medium brown, septate, cells 10–45 × 3.5–5 µm; PERIDIUM brown throughout, paler towards the centre, 20–30 µm thick in lower part, 30–60 µm in upper part, in surface view of textura angularis, with cells 5–10 µm in diam., in cross section composed of 5–10 cell layers, with isodiametric outer cells and elongate inner cells, K–; OSTIOLAR FILAMENTS abundant, 1–2 µm wide; HYMENIUM hyaline, I–, K/I–; INTERASCAL

FILAMENTS long, scarcely septate and branched, with numerous guttules, sometimes slightly moniliform, not thickened at the apex, 1–5 µm wide; ASCI unitunicate, with 4 mature spores, but sometimes with 8 spore initials, cylindrical to slightly ventricose or slightly clavate, with long foot and often rather acute apex, without apical structures, (80–)91–104–117(–130) × (10–)11–15–19(–25) µm (n = 22), I–, K/I–; ASCOSPORES uniseriate, often inclined and partly overlapping in the ascus, unicellular, elliptic, occasionally broadly or narrowly elliptic, rarely circular, lemon-shaped or narrowly ovate, at first colorless, then medium brown and K+ olive, usually with numerous small and 1(–3) large guttules, without visible perispore, (14–)20–23–26.5(–35) × (10–)11.5–13–14.5(–18.5) µm, l/b = (1–)1.5–1.8–2.1(–2.8) (n = 205); ASCOSPORE WALL smooth, scaling off when old (often by longitudinal split), 0.5–0.8 µm thick; ASCOSPORE APICES rounded or sometimes acute, occasionally with nodules (beaks) 1–1.5 µm across on both or one of the apices; CONIDIOMATA not observed.

HOSTS AND BIOLOGY — The species was found on stems and phyllocladia of *Stereocaulon alpestre*, *S. alpinum*, *S. condensatum*, *S. glareosum*, and *S. rivulorum*. No damage to the host was observed. So far *Roselliniella stereocaulorum* has been found within deciduous (Poland) or coniferous (Asia and North America) forest zones.

DISTRIBUTION — So far it has been known in 6 localities in Europe (Poland), Asiatic part of Russia (Baikal Siberia and Yakutiya) and North America (Alaska).

COMMENTS — The new species is best positioned within the genus *Roselliniella*, since it has dispersed perithecia with free brown hyphae, branched interascal filaments, 4-spored asci without distinct apical structures, and brown, simple and smooth-walled ascospores lacking germ pores. However, apical nodules found on a part of ascospores of *R. stereocaulorum* have never been seen before in any other member of the genus; the taxonomic importance of this structure can not be settled out at present. Some characters of the new species also fit the generic concepts of *Reconditella* Matzer & Hafellner, *Roselliniomyces* Matzer & Hafellner and *Roselliniopsis* Matzer & Hafellner (Matzer & Hafellner 1990, Hafellner 2004). However, *Reconditella* differs in mature ascomata lacking free hairs, 5–8-spored asci, and verruculose ascospores with a grey tint, *Roselliniomyces* has unbranched interascal filaments and verruculose ascospores, and *Roselliniopsis* has usually aggregated ascomata embedded in a subiculum and dark ascospores possessing germ pores. Apical nodules found on the ascospores of *Roselliniella stereocaulorum* may resemble germ pores of *Roselliniopsis* (as is depicted e.g. for *Roselliniopsis groedensis* in Kocourková 2000, plate 5, fig. 4), however, true germ pores of *Roselliniopsis* are often asymmetric and easily visible (J. Hafellner, pers. comm.).

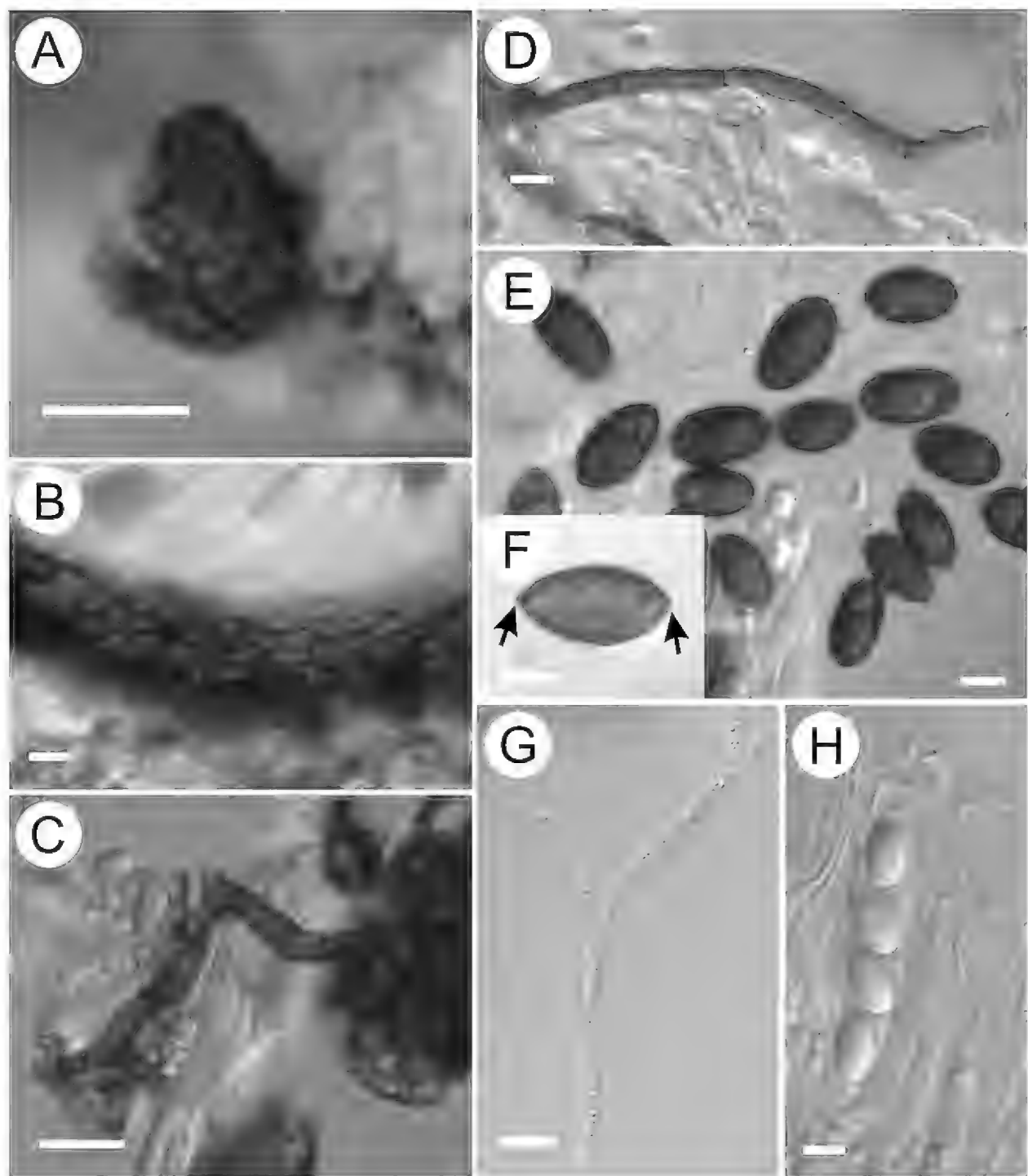


PLATE 1. *Roselliniella stereocaulorum*. A: hairy perithecium (from the holotype; scale 200 μm); B: cross section of basal perithecium wall (from LE-207727; scale 10 μm); C: vegetative hyphae (from holotype; scale 10 μm); D: ascomatal hair (from the holotype; scale 10 μm); E: ascospores (from LE-210462; scale 10 μm); F: ascospore with distinct apical nodules (arrows) (from LE-207727; scale 10 μm); G: branched interascal filament (from the holotype; scale 5 μm); H: immature ascus and interascal filaments (LE-207655; scale 10 μm).

Amongst 15 so far known *Roselliniella* species, *R. stereocaulorum* is most similar to *R. cladoniae* (Anzi) Matzer & Hafellner. The latter species differs in larger (0.15–0.7 mm wide, 0.2–0.7 mm high) perithecia, ascospores with often microguttulate surface, which can reach 52 μm in length and are occasionally

septate, (1–)2–8-spored asci and a different host genus (*Cladonia*; Matzer & Hafellner 1990).

Only two other *Roselliniella* species, *R. nephromatis* (P. Crouan & H. Crouan) Matzer & Hafellner and *R. stictae* Etayo, typically have 4-spored asci (Matzer & Hafellner 1990, Etayo, 2002). When compared with *R. stereocaulorum*, *R. nephromatis* has larger perithecia (0.4–0.7 mm wide, 0.45–0.7 mm high), slightly more elongate (arithmetic mean of length/breadth ratio: 2) and narrower [(6–) 8–11–13(–15) μm wide] ascospores with microguttulate walls, and grows on *Nephroma* species (Matzer & Hafellner 1990). *R. stictae* differs predominantly in much smaller (11–15 \times 6.5–8 μm) ascospores and *Sticta* as the host genus (Etayo 2002).

SPECIMENS EXAMINED—**POLAND.** Kotlina Biebrzańska basin. Dolina Biebrzy valley, ca. 10–11 km SSE of Grajewo town, by the railway Grajewo-Białystok, the edge of pine forest, on *Stereocaulon condensatum* growing on soil—25.09.1986, S. Cieśliński (KTC, UGDA). **RUSSIA. Baikal Siberia.** 2 km SE of Anchuk, Bol'shaya Bystraya River, 51°44'N, 103°29'E, alt. 700 m, mixed forest, by the river bank, on *S. glareosum*—09.06.2005, M. Zhurbenko 0553 (LE-233667); N slope of Khamar-Daban Range, Anosovka River, 51°30'N, 105°07'E, open pebble site by the river bank, on *S. rivulorum*—24 IX 1996, I. Urbanavichene (LE-207655); **Yakutiya.** Oimyakon District, Indigirka River downstream of Predporozhnyi, 65°03'N, 143°09'E, alt. 450 m, on *S. condensatum*—15.07.1992, M. Zhurbenko 92508:a (LE-207727:a). **USA. Alaska.** Great Kobuk Sand Dunes, 67°06'N, 159°01'W, alt. 50 m, on *S. alpinum*—11 VIII 2000, M. Zhurbenko 00111 (LE-210462).

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Literature cited

- Aptroot A, Diederich P, Sérusiaux E, Sipman HJM. 1997. Lichens and lichenicolous fungi from New Guinea. *Biblioth. Lichenol.* 64: 1–220.
- Etayo J. 2002. Aportacion al conocimiento de los hongos liquenícolas de Colombia. *Biblioth. Lichenol.* 84: 1–154.
- Etayo J, Sancho LG. 2008. Hongos liquenícolas del Sur de Sudamérica, especialmente de Isla Navarino (Chile). *Biblioth. Lichenol.* 98: 1–302.
- Hafellner J. 2004. *Roselliniopsis*. 688–689, in TH Nash III, BD Ryan, P Diederich, C Gries, F Bungartz (eds), *Lichen Flora of the Greater Sonoran Desert Region*, Vol. 2. Tempe: Lichens Unlimited, Arizona State University.

- Hawksworth DL, Miądlikowska J. 1997. New species of lichenicolous fungi occurring on *Peltigera* in Ecuador and Europe. *Mycol. Res.* 101: 1127–1134.
- Hoffmann N, Hafellner J. 2000. Eine Revision der lichenicolen Arten der Sammelgattungen *Guignardia* und *Physalospora* (*Ascomycotina*). *Biblioth. Lichenol.* 77: 1–181 + 9 plates.
- Kocourková J. 2000 [“1999”]. Lichenicolous fungi of the Czech Republic. (The first commented checklist). *Acta Mus. Nat. Pragae, Ser. B., Hist. Nat.* 55: 59–169.
- Lumbsch HT, Huhndorf SM (eds). 2007. Outline of *Ascomycota* – 2007. *Myconet* 13: 1–58.
- Lumbsch HT, Schmitt I, Mangold A, Wedin M. 2007. Ascus types are phylogenetically misleading in *Trapeliaceae* and *Agyriaceae* (*Ostropomycetidae*, *Ascomycota*). *Mycol. Res.* 111: 1133–1141.
- Matzer M, Hafellner J. 1990. Eine Revision der lichenicolen Arten der Sammelgattung *Rosellinia* (*Ascomycetes*). *Biblioth. Lichenol.* 37: 1–138.

Remarks on taxonomy and ecology of *Leucoagaricus ionidicolor* based on a find from Central Bohemia (Czech Republic)

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Abstract — Central Bohemia (Czech Republic), a region around Prague, has varied and unique habitat conditions and a long tradition of mycological research. In 2008, rare species *Leucoagaricus ionidicolor* was found there (Křivoklátsko protected landscape area) in detritus close to the fallen trunk of *Quercus* in a thermophilous broadleaved forest. It is the first find in Bohemia (west part of the Czech Republic). A thorough description and discussion on taxonomy, ecology and distribution are given.

Key words — *Basidiomycetes*, *Agaricaceae*, thermophilous fungi, Central Europe, mycogeography

Introduction

In 2007 and 2008, the author studied threatened (red-listed) species of macrofungi (Holec & Beran 2006) in Central Bohemia, a region around Prague having varied and unique habitat conditions. The landscape encompasses a rich mosaic from lowlands to the hilly country and the submontane belt, from acidic to basic or calcareous soils, from near-natural habitats to man-made landscapes (Ložek et al. 2003, 2005). Mycologically, it is an area that has been intensely studied for almost two centuries (for summaries see e.g. Svrček 1965, 1985). Fungi of thermophilous habitats (especially dry grasslands and oak-hornbeam forests; Chytrý et al. 2001) are the most remarkable group (Svrček 1960).

In 2008, the rare species *Leucoagaricus ionidicolor* was found in this region. It is the second record for the Czech Republic (CR). The first one (Antonín & Vágner 1997) originates from south Moravia (eastern part of the CR). As thorough descriptions of this species are few (Bellù & Lanzoni 1988, Candusso & Lanzoni 1990, Contu & Serra 1998, Vellinga 2001, Hausknecht & Pidlich-Aigner 2004, Derboven 2008), the Bohemian material is described here in detail and the taxonomy, ecology and distribution of *L. ionidicolor* is discussed.

Material and methods

Field work was carried out during 2007–2008. The search was focused on protected areas in Central Bohemia, both the large-scale ones (PLA: protected landscape areas Křivoklátsko, Kokořínsko, Český Kras) and the small-scale ones (nature reserves). *Leucoagaricus ionidicolor* was found only at one locality in 2008. The microscopic examinations were made using an Olympus BH-2 microscope on material mounted in a 5% KOH solution. The iodine reaction was studied in Melzer's reagent prepared according to the formula given in Moser (1983). For spore size measurements, randomly selected mature spores were used. Illustrations of microcharacters were drawn at a magnification of $500\times$ and $1250\times$ using a drawing tube. For micromorphological terminology see Bas et al. (1988). The voucher specimen is deposited in the herbarium PRM (National Museum, Mycological Department, Prague).

Abbreviations: CR: Czech Republic; L: total number of lamellae reaching the stipe.

Results

Leucoagaricus ionidicolor Bellù & Lanzoni, Rivista di Micologia

31(3–4): 107, 1988.

FIGURE 1

= *Leucocoprinus caeruleoviolaceus* D.A. Reid, Mycol. Res. 93: 413, 1989.

= *Leucoagaricus caeruleoviolaceus* (D.A. Reid) Bon, Doc. Mycol. 23(91): 33, 1993.

= *Leucoagaricus ionidicolor* var. *caeruleoviolaceus* (D.A. Reid) D.A. Reid, Mycotaxon 53: 327, 1995.

SELECTED PHOTOGRAPHS: Bellù & Lanzoni (1988), Henrici (2000), Derboven (2008).

MACROCHARACTERS (the description is based on one mature fruitbody missing the lower part of stipe) — **PILEUS** 3 cm broad, plano-concave, dry, not hygrophanous; surface completely brown-violet and granular at the very centre, towards the margin disrupted into fine, densely arranged, raised, fibrillose-tomentose, pale violet scales lying on whitish background; **LAMELLAE** crowded, L = ca. 60–70, ventricose, adnexed to almost free, purely white, with concolorous, finely eroded edge; **STIPE** (only upper part present, the lower part with the annulus was eaten off by animals) cylindrical, 0.3 cm broad; surface whitish to yellowish with pink tinge at apex, stipe covering finely fibrillose-granular, white; stipe context white, with cottony consistency; **SMELL** none; no part of the fruitbody changed colour when bruised.

MICROCHARACTERS — **BASIDIOSPORES** $(5.2\text{--})5.5\text{--}6.0(\text{--}6.5) \times 3.2\text{--}3.5(\text{--}4.0)$ μm (20 spores measured), ellipsoid to ellipsoid-ovoid; hilar appendix small but distinct; germ pore absent; wall rather thick, c. $0.5 \mu\text{m}$, smooth; spores distinctly dextrinoid in Melzer's reagent: pale vinaceous brown (D3 according to Vesterholt 2005: 18), each spore with one droplet inside (in 5 % KOH); **BASIDIA** $18\text{--}20 \times 6\text{--}7 \mu\text{m}$, rather short, clavate to narrowly clavate, 4-spored,



FIGURE 1. *Leucoagaricus ionidicolor* (PRM 915219).
B: basidia and basidiole (right), CH: cheilocystidia, S: basidiospores,
TC: terminal cells of the pileipellis hyphae.

hyaline; BASIDIOLES small, $13\text{--}15 \times 5\text{--}6 \mu\text{m}$, clavate, hyaline; LAMELLA EDGE sterile, composed of cheilocystidia arranged in tufts which are intermixed with narrow sites of parallel hyphae without cystidia; CHEILOCYSTIDIA $20\text{--}30 \times 6\text{--}10 \mu\text{m}$, clavate to narrowly clavate, with straight to curved basal part, hyaline, thin-walled, growing both at the end of their basal cell or laterally; PLEUROCYSTIDIA absent; LAMELLAR TRAMA almost irregular, not dextrinoid, of interwoven hyphae; cells $8\text{--}20 \mu\text{m}$ broad, hyaline, cylindrical to slightly inflated, some of them rather short (up to $30 \mu\text{m}$); almost globose or strongly inflated cells rarely present; SUBHYMENIUM made up of densely arranged, short to isodiametric cells; PILEUS COVERING a trichoderm of uplifted septate hyphae with yellow-brown wall and finely granular yellow-brown content having violet tinge (observed in water); cells cylindrical, $5\text{--}7 \mu\text{m}$ broad; terminal cells narrowly clavate when young, then very long, $80\text{--}200 \times 15\text{--}20 \mu\text{m}$, narrowly fusiform with rostrate apex; STIPE COVERING not studied as the stipe is almost completely absent (see above); CLAMP CONNECTIONS absent in all tissues.

MATERIAL STUDIED — CZECH REPUBLIC. Central Bohemia: W of Prague, Křivoklátsko protected landscape area, 3 km SE of Křivoklát castle near Rakovník town, STŘÍBRNÝ LUH NATURE RESERVE: E PART – GORGE CALLED ČERTŮV LUH (UPPER PART), near-natural mixed thermophilous forest (*Fagus*, *Acer*, *Carpinus*, *Fraxinus*, *Quercus*), alt. 330 m, in detritus close to fallen trunk of *Quercus*, 27. VIII. 2008 leg. and det. J. Holec (PRM 915219).

Discussion

Taxonomy

Almost all characters of my material agree well with the original description by Bellù & Lanzoni (1988) and photographs by Henrici (2000) and Derboven (2008). A small discrepancy concerns the width of terminal cells in the pileus covering which is smaller in material observed by Bellù & Lanzoni (1988: $11\text{--}16 \mu\text{m}$) and Vellinga (2001: $8\text{--}12 \mu\text{m}$). Vellinga (2001) used the width as one of the distinguishing characters against *L. marriagei* (D.A. Reid) Bon (having the width of $10\text{--}17 \mu\text{m}$ according to her; see also Reid 1966). However, my and Bellù & Lanzoni's data show that there is an overlap and the length of the terminal cells is a more distinctive character (longer in *L. ionidicolor*, shorter in *L. marriagei*). It agrees e.g. with data by Antonín & Vágner (1997), who observed terminal elements measuring $30\text{--}250 \times 6\text{--}20 \mu\text{m}$ in *L. ionidicolor*.

The spore size observed in the original material from Spain (Bellù & Lanzoni 1988) and my collection from Bohemia (this paper) is rather small, maximally reaching $6.5 \times 4 \mu\text{m}$. In other records (e.g. Antonín & Vágner 1997, Vellinga 2001, Knudsen & Vesterholt 2008) the spores are somewhat larger. *Leucoagaricus ionidicolor* apparently has a broader range of spore size [about $(5.0)5.5\text{--}7(7.5) \times (3.0)3.2\text{--}4.5(5.0) \mu\text{m}$; for references see above], with spores reaching up to $7.8 \mu\text{m}$ in length observed by Hausknecht & Pidlich-Aigner

(2004). It is interesting that one later collection from the type locality (Vila et al. 1997) had ellipsoid-amygdaliform spores reaching up to 9 µm long.

I agree with Vellinga (2001) that the two varieties distinguished by Reid (1995: *L. ionidicolor* var. *ionidicolor* and var. *caeruleoviolaceus*) represent in fact one variable species. It is supported by the overlap of characters given by Reid (1995) himself and by the overlap in characters discussed above.

It is somewhat questionable whether *Leucoagaricus ionidicolor* var. *major* J. Charb. et al. (Bon & Charbonnel 2000) really belongs to *L. ionidicolor*. The fruitbodies representing the variety are very robust [pileus up to 10–12 cm, stipe 10(–12) × 0.8(–1) cm] and the terminal elements of the pileus covering are relatively short (up to 100–150 µm). The description of microcharacters is too brief and the structures are not illustrated. Albert (2008) also presents larger and robust fruitbodies (pileus 4–8 cm, stipe 4–8 × 0.5–1 cm), also much more pink coloured than *L. ionidicolor*; unfortunately, the cells of pileus covering are not described. In my opinion, a detailed revision of these collections is necessary; unfortunately my requests for material on loan have been unsuccessful.

There are several species with a similar appearance. Briefly, *L. marriagei* (which Vellinga (2006) considers identical with the earlier described *Lepiota roseolivida* Murrill, suggesting that *L. marriagei* is a synonym) differs by slightly larger and amygdaliform spores, shorter (up to 160 µm) terminal elements, and smaller delicate fruitbodies (Reid 1995, Vellinga 2001). *Leucoagaricus ianthinophaeus* Locq. differs by exannulate stipe and pileus covering with tufts of short cylindrical elements intermixed with inflated to sphaerical cells (Locquin 1952, Reid 1995). *Leucoagaricus ianthinosquamulosus* Guinb. has longer spores, 2-spored basidia, and encrusting pigment in the pileus covering (Vellinga 2001). *Leucoagaricus jubilaei* (Joss.) Bon is very similar both macro- and microscopically (see e.g. Gennari 2007); however, it differs because of the colour changes when bruised (from yellow, rusty-orange to red).

Ecology

The Bohemian find published here is from a broadleaved forest where the fruitbodies occurred in detritus close to a fallen trunk of *Quercus*. *Leucoagaricus ionidicolor* was first found in the CR by Antonín & Vágner (1997) growing under *Quercus* and *Fraxinus* in the Ranšpurk riverine (riparian) virgin forest in SE Moravia. Occurrence in riverine forests are also cited by Vasas (2000) from Hungary (forest composed of *Quercus*, *Fraxinus* and *Ulmus*) and Hausknecht & Pidlich-Aigner (2004) from Austria. In Great Britain, the species was collected in rich soil and debris from a decayed *Carpinus* log or under fallen trunk of *Carpinus* (Henrici 2000, Legon & Henrici 2005), in southernmost Sweden on soil or strongly decomposed wood in deciduous forests (Knudsen & Vesterholt 2008), and in Austria also in a mixed forest under *Robinia* (Hausknecht &

Pidlich-Aigner 2004). On the other hand, the species was found under conifers in Spain (Bellù & Lanzoni 1988, Vila et al. 1997; under exotic trees: *Sequoia*, *Cedrus*, *Pinus*), Sardinia (Italy; Contu & Serra 1998: near *Juniperus phoenicea*), Austria (Aron et al. 2005: on litter in a coniferous forest), Great Britain (Reid 1989: under *Pinus*, as *Leucocoprinus caeruleoviolaceus*) and The Netherlands (Vellinga 2001: under *Clematis vitalba* growing around *Picea*). These data suggest that *L. ionidicolor* is able to grow both in coniferous and broadleaved forests and to decay both raw humus (litter and debris) and soft wood in final stages of decay. It occurs in natural forests as well as man-influenced and man-made habitats (parks, ruderal sites).

Distribution

To date, *Leucoagaricus ionidicolor* is known from Italy (e.g. Candusso & Lanzoni 1990, Contu & Serra 1998), Spain (e.g. Bellù & Lanzoni 1988, Rovira & Ballarà 2006), The Netherlands (Vellinga 2001), Belgium (Derboven 2008), Great Britain (Reid 1989: as *Leucocoprinus caeruleoviolaceus*, Henrici 2000, Legon & Henrici 2005), southernmost Sweden (Skåne: Lange 2005, Knudsen & Vesterholt 2008), France (e.g. Bon 1993), Czech Republic (Antonín & Vágner 1997, this paper), Austria (Pidlich-Aigner 2003, Hausknecht & Pidlich-Aigner 2004, Aron et al. 2005), and Hungary (Vasas 2000). However, the species is rare everywhere and in most countries it is known from only 1–5 localities.

Both finds in the CR originate from the warmest areas of the country. The same fact concerns most localities outside the Mediterranean. For example, in the Netherlands the calcareous hilly area is warmer than the rest of the country (pers. comm. E.C. Vellinga) and southernmost Sweden is also a relatively warm area. Generally, the species clearly prefers warmer areas of Europe (the Mediterranean, Atlantic areas of west Europe, southernmost parts of Scandinavia, warmer areas of central Europe).

There are no older collections of *L. ionidicolor* in the Czech Republic (the material in the richest herbaria PRM and BRNM was checked). As such a beautifully coloured species would certainly not escape attention of older mycologists, it is possible that these recent records may be attributable to climatic changes (e.g., the relatively warmer summers and milder winters) of the last 15 years.

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Literature cited

- Albert L. 2008. *Leucoagaricus ionidicolor* Bellù et Lanzoni. „Lilás tarló-özláb gomba.“ Mikológiai Közlemények (Clusiana) 47(1): 95–96.
- Antonín V, Vágner A. 1997. New, rare and less known macromycetes in Moravia (Czech Republic) – III. Acta Musei Moraviae, Scientiae Naturales 81: 147–156.
- Aron A, Kahr H, Michelitsch S, Pidlich-Aigner H, Prelicz D. 2005. Vorläufige Rote Liste gefährdeter Großpilze der Steiermark. Joannea Botanik 4: 45–80.
- Bas C, Kuyper TW, Noordeloos ME, Vellinga EC (eds.). 1988. Flora agaricina neerlandica, vol. 1. Rotterdam/Brookfield, A.A. Balkema.
- Bellù F, Lanzoni G. 1988. *Leucoagaricus ionidicolor* sp. nov. Rivista di Micologia 31: 107–110.
- Bon M. 1993. Les Lepiotes. In: Flore mycologique d'Europe, vol. 3, p. 1–153, Documents Mycologiques, Mémoire Hors Série no. 3. Lille, Association d'écologie et mycologie.
- Bon M, Charbonnel J. 2000. Agaricomycètes intéressants ou nouveaux du Centre de la France. Documents Mycologiques 30(119): 11–19.
- Candusso M, Lanzoni G. 1990. *Lepiota* s.l. In: Fungi Europaei, vol. 4, p. 1–743. Saronno, Libreria editrice Giovanna Biella.
- Chytrý M, Kučera T, Kočí M (eds). 2001. Katalog biotopů České republiky [Habitat catalogue of the Czech Republic]. Praha, AOPK ČR.
- Contu M, Serra D. 1998. Fungi mediterranei rariores. No. 26. Micologia e Vegetazione Mediterranea 13: 55.
- Derboven P. 2008. Découverte de *Leucoagaricus ionidicolor* au parc Paradisio de Cambron-Casteau. Revue du Cercle de Mycologie de Bruxelles 8: 18–24.
- Gennari A. 2007. Funghi interessanti della Toscana. (8° contributo). Rivista di Micologia 50(2): 139–144.
- Hausknecht A, Pidlich-Aigner H. 2004. *Lepiotaceae* (Schirmlinge) in Österreich. 1. Die Gattungen *Chamaemyces*, *Chlorophyllum*, *Cystolepiota*, *Leucoagaricus*, *Leucocoprinus*, *Macrolepiota*, *Melanophyllum* und *Sericeomyces*. Österreichische Zeitschrift für Pilzkunde 13: 1–38.
- Henrici A. 2000. Fungal portraits. No. 7: *Leucoagaricus ionidicolor*. Field Mycology 2: 75–76.
- Holec J, Beran M (eds). 2006. Červený seznam hub (makromycetů) České republiky [Red list of fungi (macromycetes) of the Czech Republic]. Příroda, Praha, 24: 1–282.
- Knudsen H, Vesterholt J (eds). 2008. Funga Nordica. Agaricoid, boletoid and cyphelloid genera. Copenhagen, Nordsvamp.
- Lange C. 2005. Släktet *Leucoagaricus*, spånskvlingar, i Sverige. Svensk Mykologisk Tidskrift 26(2): 16–30.
- Legon NW, Henrici A. 2005. Checklist of the British & Irish Basidiomycota. Kew, Royal Botanic Gardens.
- Locquin M. 1952. Une nouvelle espèce de Lépiote: *Leucoagaricus ianthinophaeus* Locquin sp. nov. Bulletin Trimestriel de la Société Mycologique de France 68: 175–177.
- Ložek V, Cílek V, Kubíková J, et al. 2003. Střední Čechy. Příroda, člověk, krajina [Central Bohemia. Nature, man, landscape]. Praha, Středočeský kraj.
- Ložek V, Kubíková J, Špryňar P, et al. 2005. Střední Čechy [Central Bohemia]. In: P Mackovčín, M Sedláček (eds.), Chráněná území ČR [Protected areas of the Czech Republic], vol. 13, p. 1–904. Praha, AOPK ČR & EkoCentrum Brno.
- Moser M. 1983. Die Röhrlinge und Blätterpilze. In: Kleine Kryptogamenflora, vol. 2b/2, ed. 5, p. 1–533. Jena, Gustav Fischer Verlag.
- Pidlich-Aigner H. 2003. Wärmeliebende Pilze in Österreich. Landesmuseum Joanneum, Botanik Newsletter 2003/2: 5–6.

- Reid DA. 1966. Coloured icones of rare or interesting fungi. Fasc. 1. Lehre, J. Cramer.
- Reid DA. 1989. Notes on some Leucocoprinoid fungi from Britain. *Mycological Research* 93: 413–423.
- Reid DA. 1995. Observations on *Leucoagaricus melanotrichus* and similar species. *Mycotaxon* 53: 325–336.
- Rovira M, Ballarà J. 2006. Llistat de recol·leccions micològiques de la comarca del Berguedà. *Bulletí de l'Associació Micològica Font i Quer* 2006/4: 59–96.
- Svrček M. 1960. Eine mykofloristische Skizze der Umgebung von Karlštejn (Karlstein) im Mittelböhmen. *Česká Mykologie* 14: 67–86.
- Svrček M. 1965. Současný stav mykologického výzkumu Československa [Über den gegenwärtigen Stand der mykofloristischen Durchforschung der Tschechoslowakei]. *Česká Mykologie* 19: 85–99, 155–174.
- Svrček M. 1985. Mykoflóra Prahy a nejbližšího okolí [Mycoflora of Prague and its vicinity]. *Natura Pragensis* 4: 1–83.
- Vasas G. 2000. Contributions to the knowledge of macrofungi of the forests along the Fekete-Körös, SE Hungary. *Studia Botanica Hungarica* 30–31: 79–86.
- Vellinga EC. 2001. 6. *Leucoagaricus* (Locq. ex) Sing. In: ME Noordeloos, TW Kuyper, EC Vellinga (eds.), *Flora agaricina neerlandica*, vol. 5, p. 85–108. Lisse etc., A.A. Balkema.
- Vellinga EC. 2006. Lepiotaceous fungi in California, U.S.A. – 3. Pink and lilac species in *Leucoagaricus* sect. *Piloselli*. *Mycotaxon* 98: 213–224.
- Vesterholt J. 2005. The genus *Hebeloma*. In: *Fungi of Northern Europe*, vol. 3, p. 1–146. Tilst Svampetryk.
- Vila J, Rocabrúna A, Tabarés M, Llimona X. 1997. Algunos hongos nuevos o interesantes de la península Ibérica. *Revista Catalana Micologia* 20: 169–176.

***Hypotrachyna carchiensis*, a new species in the *Parmeliaceae* from Ecuador**

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Abstract — *Hypotrachyna carchiensis* is described as a new species in the *Parmeliaceae*. It is thus far known only from Carchi Province in Ecuador.

Key words — lichens, paramo

Introduction

Hypotrachyna (Vain.) Hale is a cosmopolitan genus of approximately 165 species (Nash et al. 2002). The species of this genus are characterized by a thallus with sublinear, subirregular to linear, narrow lobes, truncated to subtruncate or more rarely subrotund apices, dichotomously branched rhizines, laminal imperforate apothecia, hyaline oval-ellipsoidal spores, and bifusiform conidia (Elix 1994). It has its highest diversity in tropical America and tropical Asia (Divakar et al. 2006). *Hypotrachyna* is mainly a genus of higher (between 1300 and 2400 m) elevation throughout its range in the tropics (Hale 1975, Divakar et al. 2006).

The genus is well represented in the *lichen flora* of the Northern Andes of Ecuador where about 33 species have been reported (Yáñez-Ayabaca 2009).

During a survey of the *Parmeliaceae* in Carchi Province in the Andean region of Ecuador, a new *Hypotrachyna* species was found, which is formally described below.

Materials and methods

The new species was collected by the first author at the El Angel Ecological Reserve, located in Carchi, the northernmost province of Ecuador. This ecological reserve, which is dominated by paramo vegetation rich in “frailejones” (*Espeletia pycnophylla* [Asteraceae]), includes also a remnant of *Polylepis* forest. The specimens were examined with a dissecting microscope for morphological characterization. Lichen substances were identified by thin

layer chromatography (Culberson & Ammann 1979, Elix & Ernst-Russell 1993) and by comparison with samples with known secondary metabolites. The chromatograms were developed in solvent system C.

Taxonomic description

Hypotrachyna carchiensis Yáñez-Ayabaca & Eliasaro, sp. nov.

FIG. 1

MYCOBANK MB 513114

Thallus similis *Hypotrachyna munduae* sed cum lobis angustioribus, cum isidiis laminalibus et cum acido fumarprotocetrarico in medulla.

TYPE: ECUADOR. CARCHI: El Angel. RESERVA ECOLÓGICA EL ANGEL, paramo of “frailejones”, 00°40’40.2” N, 77°52’35.00”W, 3739 m, 25/12/2007, A. Yáñez-Ayabaca 1453b (Holotype QAP; isotype UPCB).

ETYMOLOGY: From Carchi, the place of origin of the type material.

Thallus 4.5 cm wide, membranaceous, corticolous, loosely adnate, yellow-green. Lobes (0.6–)1.0–2.5 mm wide, 6–2 mm long, sublinear to subirregular dichotomously branched, flat to subcanaliculate, separate to slightly overlapping, apices truncate to acute, margins smooth to laterally slightly crenate. Upper surface smooth to rugose, continuous to rarely fissured in some parts, shiny, emaculate, moderately isidiate. Isidia laminal, simple, short-cylindrical, 0.1–0.3 mm long., brown-tipped, eciliate. Medulla white. Lower surface black, shiny, slightly rugose, moderately rhizinate; margin brown, smooth to slightly rugose, 0.1–0.3 mm wide, naked to partially rhizinate; rhizines black, densely dichotomously branched, 0.2–1.3 mm long, scattered but sometimes subapically grouped. Apothecia and pycnidia absent.

CHEMISTRY: cortex K–, UV–: usnic acid and atranorin (trace); medulla: K+ yellow brown, C–, KC+ brown yellow, UV–: fumarprotocetraric acid.

ADDITIONAL SPECIMENS EXAMINED – ECUADOR. CARCHI: El Angel. RESERVA ECOLÓGICA EL ANGEL, paramo of “frailejones”, 00°40’40.2”N, 77°52’35.00”W, 3739 m, 25/12/2007, A. Yáñez-Ayabaca 1467, 1468 (QAP, UPCB).

COMMENTS – *Hypotrachyna carchiensis* is characterized by its yellow-green thallus with the laminal isidia and the presence of fumarprotocetraric acid in the medulla. It is closely related to *H. munduae* Louwhoff & Elix, which can be distinguished by the wider lobes (1.5–4.5 mm wide), the subterminal isidia, and by the additional production of succinprotocetraric acid (minor), quaesitic acid (minor), protocetraric acid (minor/trace), salazinic acid 9 α -methyl ether (trace), and \pm salazinic acid (trace) in the medulla (Louwhoff & Elix 2002).

Hypotrachyna neoflavida Hale & López-Fig., a saxicolous species, is morphologically very similar to *H. carchiensis* but can be separated by the presence of protocetraric acid in the medulla and by a densely rhizinated lower surface.

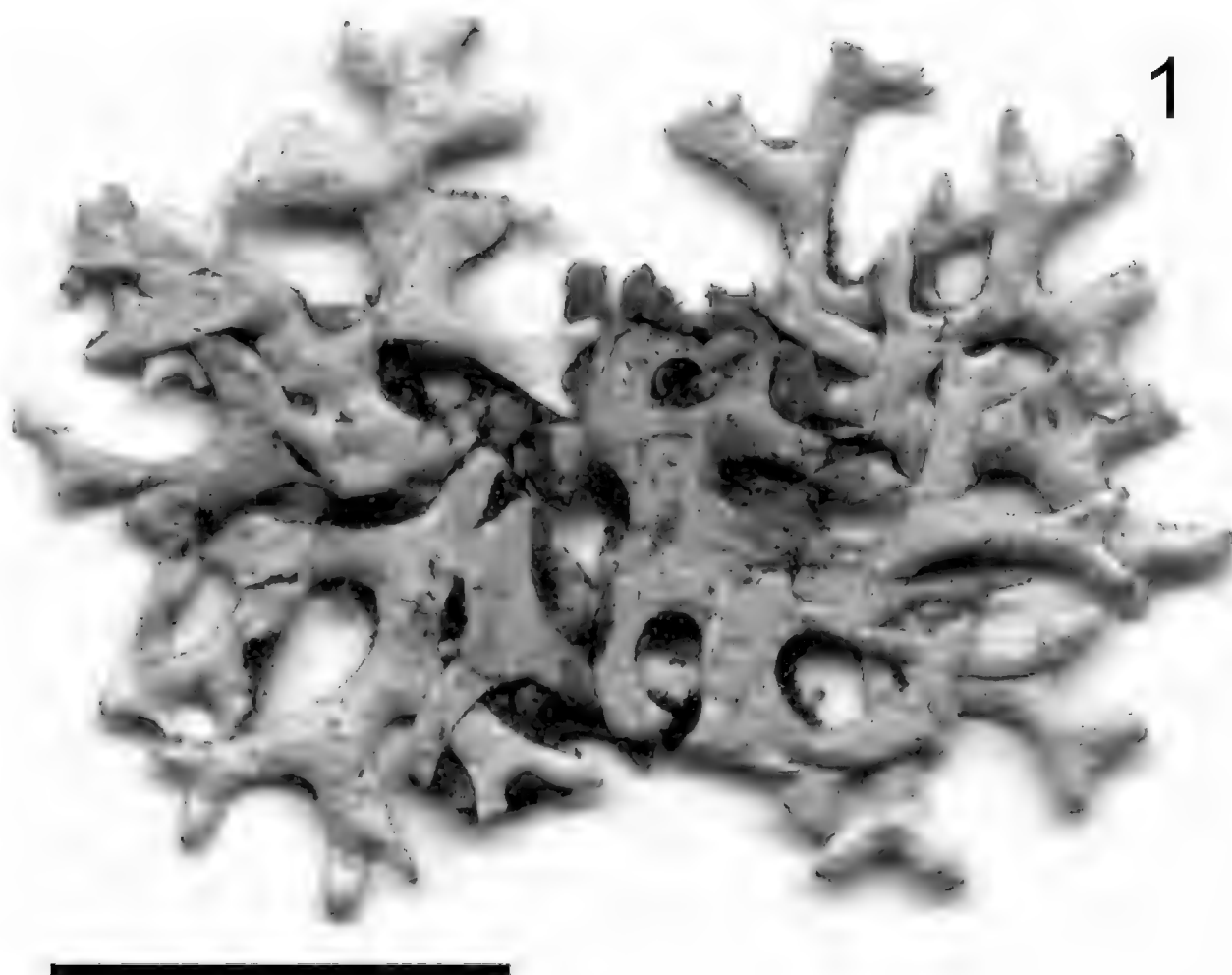


FIGURE 1. *Hypotrachyna carchiensis* (holotype QAP) Bars = 10 mm.

Acknowledgements

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Literature cited

- Culberson CF, Ammann K. 1979. Standardmethode zur Dünnschicht-chromatographie von Flechtensubstanzen. *Herzogia* 5: 1–24.
- Divakar PK, Crespo A, Blanco O, Lumbsch HT. 2006. Phylogenetic significance of morphological characters in the tropical *Hypotrachyna* clade of parmelioid lichens (*Parmeliaceae*, *Ascomycota*). *Molecular Phylogenetics and Evolution*. 44: 448–452.
- Elix JA, Ernst-Russell KD. 1993. A catalogue of standardized thin layer chromatographic data and biosynthetic relationships for lichen substances. 2nd edition, Australian National University, Canberra.

- Elix JA. 1994. *Hypotrachyna*, Flora of Australia 55: 49–59.
- Hale ME. 1975. A revision of lichen genus *Hypotrachyna* (*Parmeliaceae*) in Tropical America. *Smithsonian Contributions to Botany* 32: 1–73.
- Louwhoff, SH, Elix JA. 2002. *Hypotrachyna* (*Parmeliaceae*) and allied genera in Papua New Guinea. *Bibliotheca Lichenologica* 81: 1–149.
- Nash III TH, Sipman H, Elix JA. 2002. *Hypotrachyna*. In: Nash III TH, Ryan BD, Gries C, Bungartz F (Eds). *Lichen Flora of the Greater Sonoran Desert Region I*: 238–251.
- Yáñez-Ayabaca, A. 2009. Os gêneros *Hypotrachyna* e *Everniastrum* (*Parmeliaceae*, *Ascomycota* Liquenizados) nas províncias de Carchi e Imbabura na região Andina do Equador. Dissertação (mestrado). Universidade Federal do Paraná. Paraná. 128 p. Available at <http://dspace.c3sl.ufpr.br/dspace/>

Two new records of the genus *Laboulbenia* from China

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Abstract —Two species of the genus *Laboulbenia* are reported for the first time from China. These are *Laboulbenia bledii* on *Bledius* sp. and *Laboulbenia rigida* on *Trigonotoma lewisi*. All specimens examined were deposited in Guangdong Institute of Microbiology Macrofungi Herbarium (GDGM), Guangzhou, China.

Key words —East Asia, *Laboulbeniales*, taxonomy

Introduction

The genus *Laboulbenia* Mont. & C.P. Robin (Robin 1853) is the largest in the order *Laboulbeniales* and includes about 593 species (Tavares 1985, Kirk et al. 2008). The host insects of this genus belong chiefly to the orders *Coleoptera*, *Diptera*, *Heteroptera*, and *Isoptera*. Forty-eight species and five varieties of *Laboulbenia* have been reported from China so far (Juan & Chien 1996, 1997; Terada et al. 2004; Lee et al. 2006; Shen & Ye 2006).

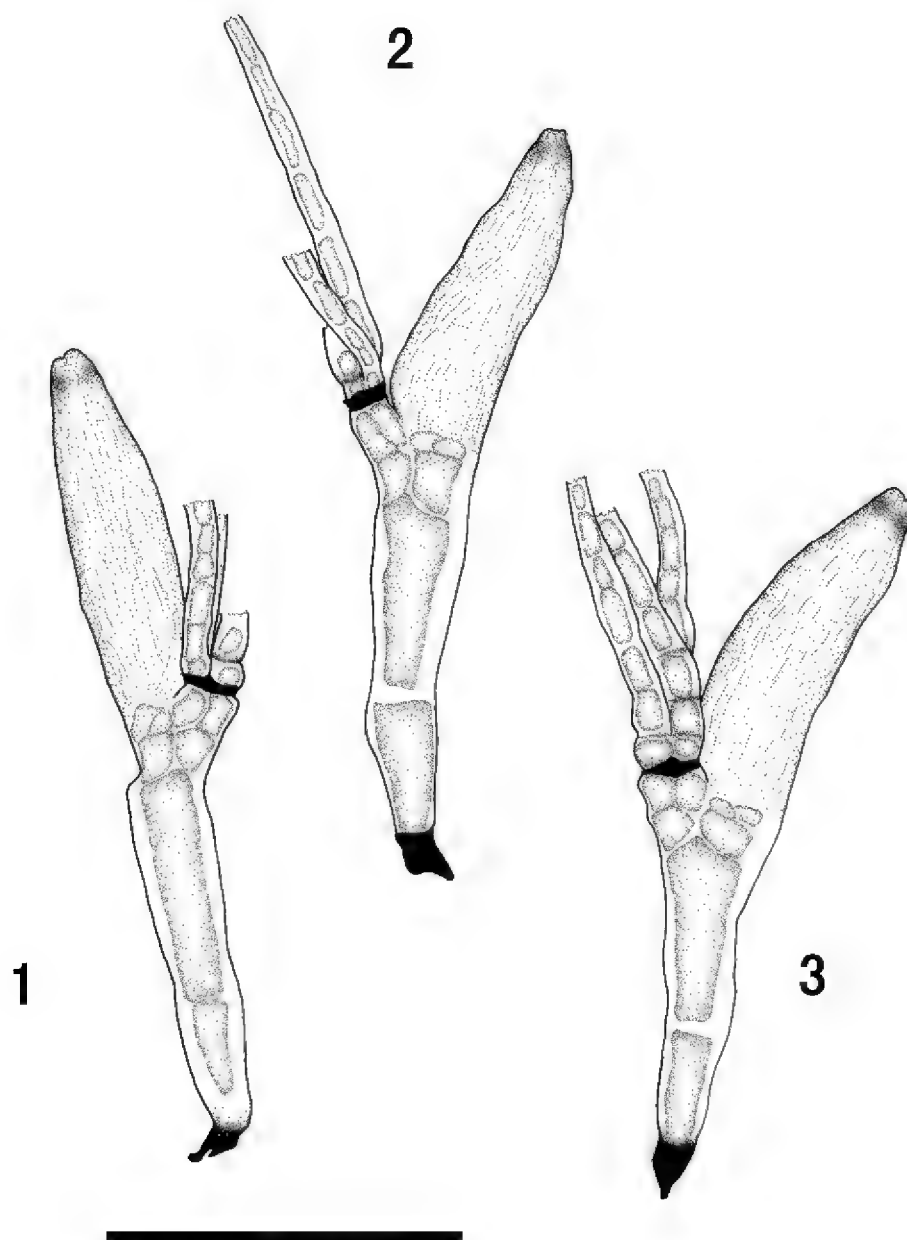
The aim of this paper is to present additional information on the occurrences and distribution of two species recently recorded in China for the first time. The descriptions are based on Chinese collections.

Taxonomy

Laboulbenia bledii Thaxt., Proc. Amer. Acad. Arts Sci. 38: 27 (1902) FIGS. 1–3.

THALLUS straight or slightly curved, pale dirty yellow, 216.0–240.0 µm long from base of foot to tip of perithecium. FOOT rather small, blackish, nearly conical, 14.4–19.2 µm long. RECEPTACLE cylindrical, gradually tapering towards the base, 112.0–131.2 µm long; cell I twice longer than broad, straight, 32.0–38.4 × 12.8–20.8 µm; cell II longer than cell I, cylindrical, 52.8–65.6 µm;

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FIGS 1–3. *Laboulbenia bledii*. Bar = 100 μ m.
 FIGS 1–2. Mature individual (GDGM 60615-1).
 FIG 3. Mature individual (GDGM 60615-3).

cells III, IV, and VI subequal, $9.6\text{--}16.0 \times 6.4\text{--}16.0 \mu\text{m}$; cell V subequal to cell IV in length, with nearly half of the upper portion free. INSERTION CELL free, flattened, blackish, slightly constricted, $3.2\text{--}5.6 \times 12.8\text{--}16.0 \mu\text{m}$. APPENDAGES composed of three straight closely arranged branches; the outer appendage simple; the inner appendage with the basal cell somewhat smaller than that of the outer appendage, bearing a branch on either side similar to the outer appendage. PERITHECIUM near completely free, slender and straight, tapering to the tip; the lip-cells rather coarse, prominent, with a subterminal blackish shade on the two sides, $99.2\text{--}104.0 \times 28.8\text{--}32.2 \mu\text{m}$.

HOST: On elytra and abdomen of *Bledius* spp. (Coleoptera, Staphylinidae), e.g. *B. jacobinus* (Thaxter 1908).

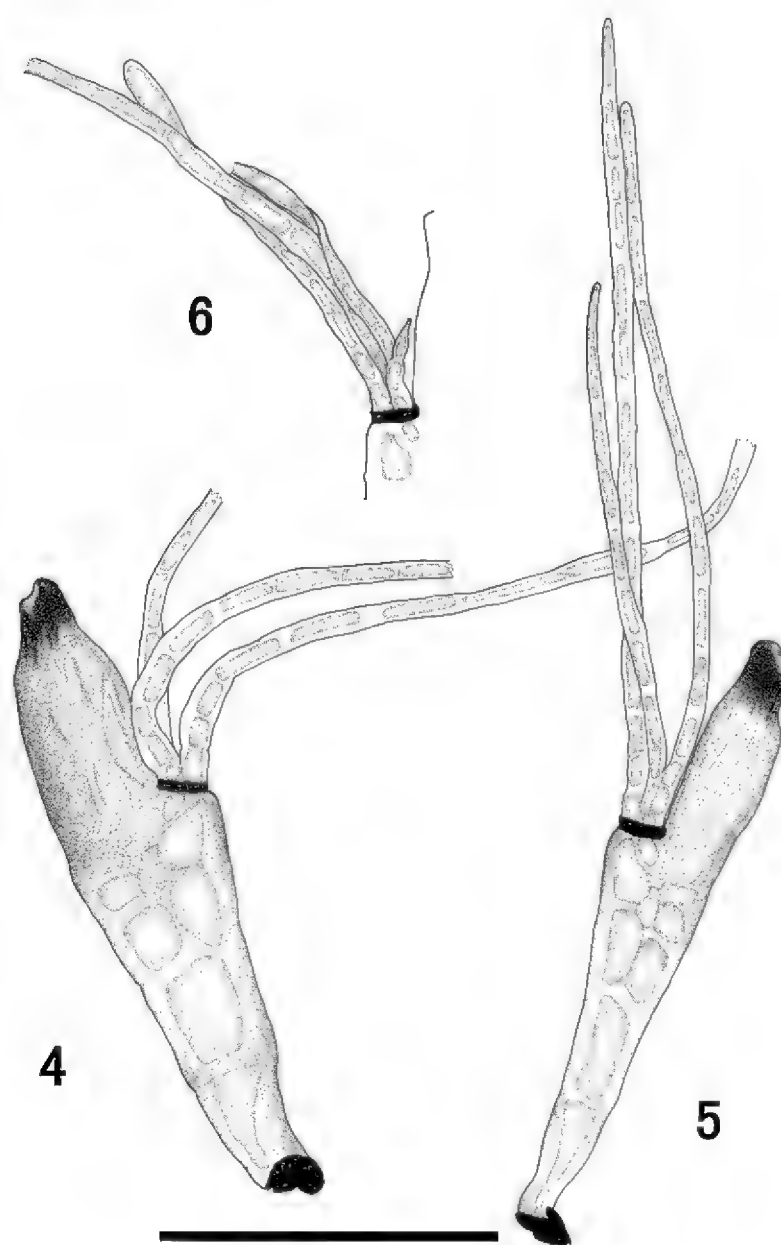
SPECIMEN EXAMINED: China, Yunnan province, Mengla county, on the surfaces of the abdomen and elytra of *Bledius* sp., 24 Jul 1985, Dong-Hai Ye, GDGM 60615-1, 60615-3.

KNOWN DISTRIBUTION: America (Thaxter 1908), China (this study).

REMARK: The main features of *Laboulbenia bledii* are: (1) nearly half of the upper portion of cell V is free; (2) cell II is usually two times longer than cell I or even longer; (3) the outer appendage is simple without any branches, and the inner appendage is also simple, but dichotomous. The Chinese collection generally fits the description given by Thaxter (1902).

Laboulbenia rigida Thaxt., Proc. Amer. Acad. Arts Sci. 30: 475 (1895). FIGS. 4–6.

THALLUS straight, more or less deeply tinged with olive brown, 195.2–205.0 μm long from the base of foot to tip of the perithecium. FOOT rather small, blackish, nearly conical, 12.0–15.2 μm long. RECEPTACLE cylindrical, sometimes rather long, gradually tapering towards the base, 125.6–130.0 μm long; cell I twice



FIGS 4–6. *Laboulbenia rigida*. Bar = 100 μm .

FIG 4–5. Mature individual (4: GDGM 60398-2; 5: GDGM 60398-3).

FIG 6. Appendages with solitary sessile antheridia (GDGM 60398-1).

longer than broad, straight, $32.0\text{--}37.6 \times 10.0\text{--}25.6 \mu\text{m}$; cell II as long as cell I, cylindrical; cells III, IV, and VI subequal in length, $17.6\text{--}24.0 \times 10.0\text{--}16.0 \mu\text{m}$; cell V small, nearly triangular, $4.8\text{--}9.6 \times 3.2\text{--}3.5 \mu\text{m}$. INSERTION CELL flattened, blackish, slightly constricted, $3.2\text{--}4.0 \times 14.4\text{--}18.9 \mu\text{m}$. Appendages arising from two basal cells; the outer appendage producing a single simple, slightly tapering branch, consisting of 8–14 cells, $131.3\text{--}241.6 \mu\text{m}$ long; the inner appendage producing two similar branches, simple, consisting of 9–11 cells, and bearing solitary sessile antheridia near the base. ANTHERIDIA cylindrical, tapering towards the distal end, $12.8 \times 4.0 \mu\text{m}$. PERITHECIUM near completely free, straight, somewhat inflated, quite opaque, with a stout, snout-like and slightly inward bent apex, $81.6\text{--}91.2 \times 24.0\text{--}35.2 \mu\text{m}$.

HOST: On *Pterostichus patruelis* (Thaxter 1895).

SPECIMEN EXAMINED: China, Yunnan province, Jinghong county, on the surface of the thorax of *Trigonotoma lewisi* (Coleoptera, Carabidae), 17 Jul 1985, Dong-Hai Ye, GDGM 60398-1, 60398-2, 60398-3.

KNOWN DISTRIBUTION: America (Thaxter 1895), France (Lepesme 1941), Italy (Colla 1934), China (this study).

REMARK: *Laboulbenia rigida* is distinguished by its rigid, straight, simple appendages and solitary sessile antheridia, usually occurring near the base of the inner appendage branch, and the nearly completely free, opaque perithecium. The Chinese collection generally conforms with the description given by Thaxter (1895), except for the longer appendages, and different host genus within the same family (Carabidae).

Acknowledgments

The authors express their hearty thanks to Prof. Dong-Hai Ye for specimen collections cited in this paper, and Dr. Lin Zhu, State Key Laboratory for Bio-Control and the Institute of Entomology, Zhongshan University of China, for the identification of the host insects. David Mitchell and Prof. Walter Rossi are thanked for presubmission review of the manuscript. The project was supported by the National Natural Science Foundation of China (No.30770004, 30870019) and the Natural Science Foundation of Guangdong (No. A06020222, E05202480).

Literature cited

- Colla S. 1934. *Laboulbeniales, Peyritsiellaceae, Dimorphomycetaceae, Laboulbeniaceae Heterothallicae, Laboulbeniaceae Homothallicae, Ceratomycetaceae*. 16: 1–157. In: Flora Italica Cryptogama, Pars I: Fungi. Società Botanica Italiana, Rocca S. Casciano.
- Juan LY, Chien CY. 1996. Study on the *Laboulbeniales* (Ascomycetes) of Taiwan (II). Biol. Bull. NTNU. 31: 5–11.
- Juan LY, Chien CY. 1997. Study on the *Laboulbeniales* (Ascomycetes) of Taiwan (III). Biol. Bull. NTNU. 32: 59–63.

- Kirk PM, Cannon PF, David JC, Stalpers JA. 2008. Dictionary of the Fungi. 10th ed. Wallingford, UK: CAB International.
- Lee YB, Na YH, Lim CK. 2006. Notes on two species of the *Laboulbeniales* from Tibet. Microbiology 34: 41–43.
- Lepesme P. 1941. Catalogue des *Laboulbéniales* de la collection François Picard. Bull. Mus. Hist. Nat. [Paris] (2^e sér.) 13: 481–488.
- Robin CP. 1853. Histoire Naturelle des Végétaux Parasites qui croissent sur l'Homme et sur les Animaux Vivants. Vol 1. J.-B. Baillière: Paris. 702 pp.
- Shen YH, Ye DH. 2006. Flora Fungorum Sinicorum Vol. 28: *Laboulbeniales*. Beijing: Science Press. 1–294.
- Tavares II. 1985. *Laboulbeniales* (Fungi, Ascomycetes). Mycol. Memoir 9: 1–627.
- Terada K, Hsu MH, Wu WJ. 2004. Notes on the carabidicolous *Laboulbeniales* (Ascomycetes) of Taiwan I. Bot. Bull. Acad. Sin. 45: 87–94.
- Thaxter R. 1895. Notes on *Laboulbeniaceae*, with descriptions of new species. Proc. Amer. Acad. Arts Sci. 30: 467–481.
- Thaxter R. 1902. Preliminary diagnoses of new species of *Laboulbeniaceae*. V. Proc. Amer. Acad. Arts Sci. 38: 7–57.
- Thaxter R. 1908. Contribution toward a monograph of the *Laboulbeniaceae*. Part II. Mem. Amer. Acad. Arts Sci. 13: 217–469.

***Ceratomyces hyalinus*, a new species from China**

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Abstract — *Ceratomyces hyalinus* on *Hydrochus annamita* (Hydrochidae, Coleoptera) is described and illustrated as a new species. The type of this species is deposited in Guangdong Institute of Microbiology Macrofungi Herbarium (GDGM), Guangzhou, China.

Key words — *Ascomycetes*, *Laboulbeniales*, taxonomy

Introduction

Ceratomyces Thaxt. is a small genus of *Laboulbeniales* with only recognized 20 species (Tavares 1985, Santamaría 1999). Among them, 18 have been described as occurring on *Tropisternus* (Hydrophilidae, Coleoptera) from America (Tavares 1985), one on *Sternolophus* (Hydrophilidae) from southeast Asia (Tavares 1985), and another on *Hydrobius* (Hydrophilidae) from Europe (Santamaría 1999). The genus is characterized by a receptacle of usually 3–4 cells, outer wall cells flattened in alternate vertical rows, other 2 rows with subequal or conspicuously longer and narrower cells, rows usually appearing 3 across, wall cell tiers usually 20 or more (rarely as few as 13), and a perithecium with a slender subterminal or terminal horn (usually multicellular) on only one side (Tavares 1985). In this paper, a new species of *Ceratomyces* is described, and *Hydrochus* is reported as the first member of *Hydrochidae* parasitized by *Ceratomyces*.

Materials and methods

All insect specimens were examined by a binocular dissecting microscope. The thalli were first removed from the insect bodies using a watchmaker's (Juan & Chien 1997) or acupuncture needle and then mounted on a slide.

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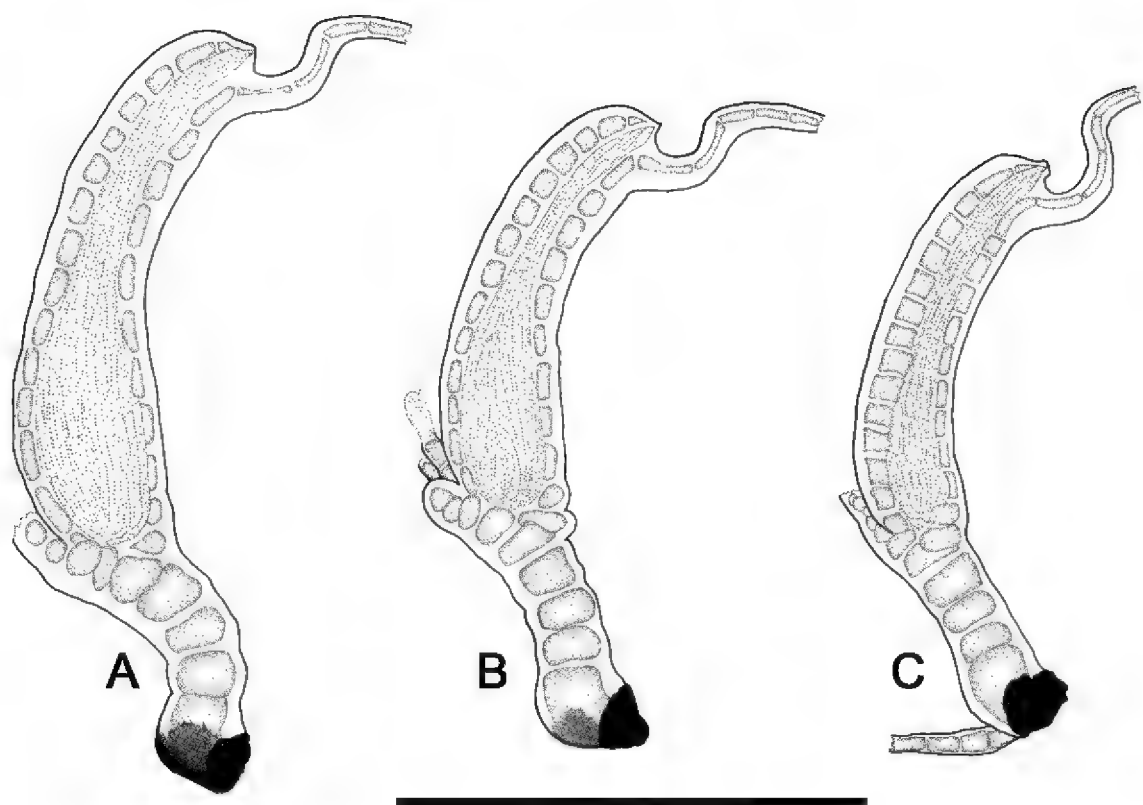


FIG 1. Mature thalli of *Ceratomyces hyalinus*. Bar = 100 μ m.
A. GDGM 60879-3a (Holotype);
B. GDGM 60879-3b (Isotype); C. GDGM 60879-3c (Isotype).

The fungus slides were prepared following the method described by Benjamin (1971) and Huldén (1983). Permanent slides are deposited in the Herbarium of Microbiology Institute of Guangdong Province (GDGM).

Taxonomy

Ceratomyces hyalinus Y.H. Shen, sp. nov.

FIG. 1.

MYCOBANK MB 891

THALLUS *hyalinus*, 137–175 μ m longus. *RECEPTACULUM* ex 4–5 cellulis superpositis constans, curvatum antrorsum, cellulae basilaris parte inferna opaca, longitudo latitudinem paene aequans, cellulis ceteris fere dimidio longioribus quam latioribus. *PERITHECIUM* 83–107 μ m longum, 18–37 μ m latum, ad apicem attenuatum, postice curvatum, processum subsigmoideum subterminaliter ac postice ferens. Appendix brevis ex 3–4 cellulis superpositis constans, ad apicem attenuata.

HOLOTYPE: China, Hainan Province, Guangdong province, Nankunshan Provincial Nature Reserve, on the abdomen of *Hydrochus annamita* Régimbart, 13 Jul 1987, Ya-Heng Shen, GDGM 60879-3a. (Isotypes: GDGM 60879-3b; GDGM 60879-3c).

ETYMOLOGY: From Latin *hyalinus* = glassy, without any color.

THALLUS hyaline, 119–157 μ m and 137–175 μ m long from base of foot to tip of the perithecium and to its perithecial apex respectively. **RECEPTACLE** 41–62

× 14–24 µm, consisting of 4–5 flattened cells, usually bending slightly forward; basal cell usually black in lower part, with the length sub-equal to the breadth and the length of the remaining cells of the receptacle is about half of the width. PERITHECIUM 83–107 × 18–37 µm, strongly curved towards the ventral side in the upper half and gradually narrowing towards the tip; with about 15 flattened cells in ventral row of perithecial wall, and about 10 cells in dorsal row of perithecial wall; with a slender, shorter, sigmoid, multicellular perithecial appendage formed by the distal cell, 32–45 × 3–11 µm, consisting of about 4–5 cells, which commonly diverges at an angle of 45 degrees or more. APPENDAGE 21–30 × 8–16 µm, short, consisting of about 3–4 flattened cells, gradually tapering towards the tip, usually bearing short lateral branches at the apex.

REMARK: The diagnostic features of *Ceratomyces hyalinus* are its hyaline thallus except for the basal cell of the receptacle, the perithecial wall cells consisting of about 10–15 flattened cells only, the receptacle with 4–5 flattened cells, and the simple perithecial appendage.

Acknowledgments

The project was supported by the National Natural Science Foundation of China (No.30770004, 30870019) and the Natural Science Foundation of Guangdong (A2000204, E05202480). The authors express their hearty thanks to Prof. Dong-Hai Ye for his assistance in partial work of *Laboulbeniales*, Dr. Feng-Long Jia, the Institute of Entomology, Zhongshan University of China, for the identification of the host insects, and David Mitchell and Prof. Walter Rossi for presubmission reviews of the manuscript.

Literature cited

- Benjamin RK. 1971. Introduction and supplement to Roland Thaxter's Contribution towards a Monograph of the *Laboulbeniaceae*. Bibiotheca Mycol 30: 1–155.
- Huldén L. 1983. *Laboulbeniales* (Ascomycetes) of Finland and adjacent parts of the U.S.S.R. Karstenia 23: 31–136.
- Juan LY, Chien CY. 1997. Study on the *Laboulbeniales* (Ascomycetes) of Taiwan (III). Biol. Bull. NTNU. 32: 59–63.
- Santamaría S. 1999. New and interesting Iberian *Laboulbeniales* (Fungi, Ascomycota). Nova Hedwigia 68: 351–364.
- Tavares II. 1985. *Laboulbeniales* (Fungi, Ascomycetes). Mycol. Memoir 9: 1–627.

The genus *Trochila* in Bulgaria

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Abstract — Two species of *Trochila* occurring on leaves of relict plants (*T. ilicina* on *Ilex* spp. and *T. laurocerasi* on *Laurocerasus officinalis*) are reported for the first time from Bulgaria, while *T. craterium* is recorded from a number of new localities. The three species are described, illustrated, and their known distribution in the Balkans and neighbouring countries noted. A morphology-based key to *Trochila* in Bulgaria is also provided. The possibly threatened status of the species in Bulgaria is also addressed.

Key words — discomycetes, Ascomycota, Dermateaceae, Helotiales

Discomycetes have been studied in Bulgaria for quite a long time, as reflected by the 420 species of *Helotiales*, *Pezizales*, and *Rhytismatales* recorded in the most recent overview (Denchev & Bakalova 2002). However, new species are constantly found and there is still need for further research.

The present work describes three species of *Trochila*, each attached to the dead leaves of an apparently different plant genus in Bulgaria: *T. ilicina* on holly (*Ilex*), *T. laurocerasi* on cherry laurel (*Laurocerasus*), and *T. craterium* on ivy (*Hedera*).

Materials and methods

Dried specimens were examined in lactophenol with cotton blue, Melzer's reagent (Kirk et al. 2008), and distilled water. Apothecia were rehydrated before being described and measured. The studied specimens are held in the mycological collections (SOMF) of the Institute of Botany, Bulgarian Academy of Sciences, Sofia. Collector abbreviations include DYS (Stoykov) and BA (Assyov). The descriptions and key are based on Bulgarian specimens. Additional specimens from the United Kingdom, Turkey, Poland, Romania and Hungary were studied for comparison with those from Bulgaria (see TABLES 1, 2 & 3, p. 356). Line drawings were prepared by tracing digital photograph images onto transparent paper. The photographs were taken from slides in

lactophenol with Canon PowerShot A630 on Boeco BM-180/T/SP microscope. Species concepts follow Greenhalgh & Morgan-Jones (1964), Dennis (1978), Coste & Rey (1994), and Zioło et al. (2005). The taxonomy of the genus is in accordance with the latest *Ascomycota* outline (Lumbsch & Huhndorf 2007).

Results

Trochila craterium (DC.) Fr., Summa Veg. Scand., p. 367, 1849 FIG. 1, TABLE 1

APOTHECIA immersed in leaf tissue, sessile, densely disposed, at first globose later expanding, opening by a variable number of irregularly torn teeth, discoid. Disc 150–300(–400) μm , dark-brown. ASCI (45–)65–80(–85) \times 7.5–12(–15) μm , clavate, arising from croziers, with a small pore blued by iodine, 8-spored. ASCOSPORES (4.5–)7–9(–10) \times (2.5–)3–5(–6), mean $7.1 \times 3.9 (\pm 1.1 \times \pm 0.6) \mu\text{m}$, L/W ratio usually <2 ($n = 500$), broadly elliptical, unicellular, biseriate, hyaline. PARAPHYSES cylindrical, septate, clavate at the top, 2–3.5(–4) μm wide.

DISTRIBUTION IN THE BALKANS — Bulgaria: Blagoevgrad, Burgas, Lovech, Petrich, Plovdiv, Sofia, & Varna districts; Romania (Bontea 1985).

SPECIMENS EXAMINED: BULGARIA. On dry leaves of *Hedera helix* L.: **BLACK SEA COAST (NORTH): Varna distr.** ALBENA, Seaside Resort 1.VI.2006 DYS (SOMF 26384); **Dobrich distr.** BALCHIK TOWN, Botanical Garden (43°25'N 28°10'E) alt. ca 20 m 4.VI.2006 DYS (SOMF 26799); **Varna distr.** KAMCHIYA RIVER 12.IX.2006 BA (SOMF 26378), Flooded forests 29.VII.2008 BA (SOMF 26727); **BLACK SEA COAST (SOUTH): Burgas distr.** ARKUTINO LOCALITY 8.VI.2008 BA (SOMF 26393); ROPOTAMO NATURE RESERVE, on the right river bank, 10.IX.2008 DYS & BA (SOMF 26741); PRIMORSKO VILLAGE, along trail to Maslen Nos cape, mixed oak-ash forests (42°16'N 27°46'E) alt. ca 0 m 9.IX.2008, BA & DYS (SOMF 26742); **FOREBALKAN: Lovech distr.** PATRESHKO VILLAGE, Dalevska mahala (42°55'N 24°46'E) alt. ca 571 m 2.VII.2006 DYS (SOMF 26376), Predela locality 2.V.2008 DYS (SOMF 26392), near new water power building 4.V.2008 DYS (SOMF 26382); GOLYAMA ZHELYAZNA VILLAGE, Promkombinat locality 5.V.2008 (42°58'N 24°28'E) alt. ca 503 m DYS (SOMF 26383), 13.V.2008 DYS (SOMF 26387), 21.VI.2008 DYS (SOMF 26391); **Sofia distr.** along the road to Milanovo village (43°11'N 23°39'E) alt. ca 550 m 7.VII.2006 DYS (SOMF 26374); **STARA PLANINA Mts: Lovech distr.** ORESHAK VILLAGE (42°53'N 24°46'E) alt. ca 473 m 1.VII.2006 DYS (SOMF 26379); TOWN OF TROYAN (42°53'N 24°43'E) alt. ca 510 m 2.V.2008 DYS (SOMF 26390); **SOFIA REGION: Sofia distr.** SOFIA, Geo Milev estate 14.IV.2008 DYS & BA (SOMF 26380); Borisova Gradina park (42°41'N 23°19'E) alt. 592 m 2.VI.2008 DYS (SOMF 26388); **BELASITSA Mt: Petrich distr.** ABOVE SAMOUILOVO VILLAGE 10 May 1994 V. Fakirova (SOMF 21490; see also Dimitrova 1997a); **PIRIN Mts (SOUTHERN): Blagoevgrad distr.** TOWN OF MELNIK (41°31'N 23°24'E) alt. 438 m 16.V.2008 BA (SOMF 26385); **RHODOPI Mts (CENTRAL): Asenovgrad distr.** BACHKOVSKI MONASTERY 22.VII.1992 V. Fakirova (SOMF 21007; 21300; see also Dimitrova 1997b).

EXTRALIMITAL SPECIMENS EXAMINED: **UNITED KINGDOM.** LONDON, SOUTHWARK, between Jamaica Road and Chambers Str. 19.I.2008 DYS (SOMF 26381), on dry leaves of *Hedera algeriensis* Hibberd; COTEBROOKE, CHESHIRE 18.VI.2007 BA (SOMF 26373), on dry leaves of *H. helix*; **HUNGARY.** SZEKSZÁRD CEMETERY 24.VI.1928 L. Hollós (SOMF

6163), on dry leaves of *H. helix*; DÉDESVÁR, Bükk Hegység Mt 17.VIII.1960 S. Tóth (SOMF 6164), on dry leaves of *H. helix*; POLAND. KRAKÓW, RAKOWICKI CEMETERY 4.X.2008 DYS (SOMF 26800), on dry leaves of *H. helix*; ROMANIA. TRANSYLVANIA: CLUJ 5.VI.1961 M. Bechet (SOMF 9854), on dry leaves of *H. helix*.

Trochila ilicina (Nees : Fr.) Courtec., in Courtecuisse et al.,
Doc. Mycol. 16(62): 5, 1986

FIG. 2, TABLE 2

APOTHECIA often with remnants of covering attached as lid, scattered, on the upper side of the leaves, immersed in leaf tissue, discrete, circular, sometimes confluent in dead leaf tissues, black, opening by shedding a circular patch of host epidermis. DISC circular or irregular in confluent ascomata, 350–500(–700) μm in diam, dark greyish. ASCI (50–)65–75(–90) \times (5–)8–10(–11) μm , clavate, arising from croziers, with a small pore blued by iodine, 8-spored. ASCOSPORES (4.5–)9–13.5 \times 3.5–5.5, mean 11.6 \times 4.5 ($\pm 1.0 \times \pm 0.4$) μm , L/W ratio usually >2 ($n = 100$), hyaline, elliptical to ovoid, non-septate, biseriate (sometimes tending to uniseriate) in the ascus. PARAPHYSES cylindrical, septate, clavate at the top, up to 4.5 μm wide at the apex.

DISTRIBUTION IN THE BALKANS — Bulgaria: Burgas & Petrich districts, Greece (Pantidou 1973), Romania (Bontea 1985), Turkey (Stoykov & Denchev 2007).

SPECIMENS EXAMINED: BULGARIA. On fallen leaves of *Ilex aquifolium* L.: BELASITSA MT: Petrich distr. between Belasitsa hut and the waterfall (41°36'84"N 23°18'52"E) 15.IX.2003 BA (SOMF 25408); On fallen leaves of *I. colchica* Pojark: STRANDZHA MT: Burgas distr. MARINA RJAKA protected area 27.V.2005 BA (SOMF 25720).

EXTRALIMITAL SPECIMENS EXAMINED: UNITED KINGDOM. Cheshire: SANDYMERE, Oakmere reservoir 20.VI.2007 BA (SOMF 26354), on fallen leaves of *I. aquifolium*; ROMANIA. Ilfov distr: BUCHAREST, BOTANICAL GARDEN 7.II.2007 BA (SOMF 26386), on fallen leaves of *I. aquifolium*; TURKEY. STRANDZHA MT: KURU DERE RAVINE 1.VI.2007 DYS (SOMF 26314), on fallen leaves of *I. colchica*.

For the nomenclature of this species the reader is referred to Courtecuisse et al. (1986).

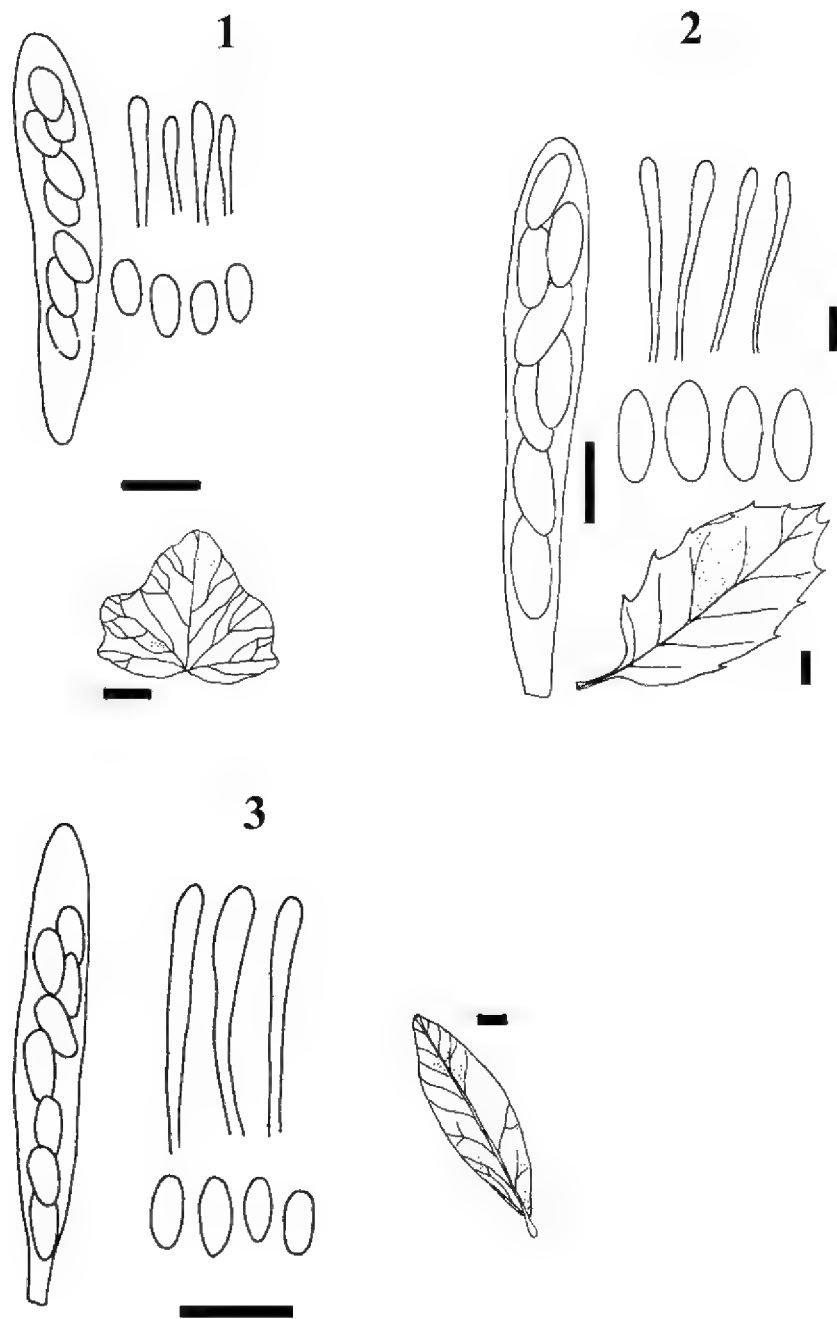
Trochila laurocerasi (Desm.) Fr., Summa Veg. Scand., p. 367, 1849 FIG. 3, TABLE 3

APOTHECIA numerous, scattered, subcuticular, discrete, circular, sometimes confluent, immersed in dead leaf tissue, opening by shedding a circular patch of host epidermis. DISC circular or rarely irregular in confluent ascomata, (220–)260–350(–500) μm in diam, dark grey. ASCI 45–70(–85) \times 5.5–10(–13) μm , clavate, arising from croziers, with pore ca 1 μm long and blued by iodine, 8-spored. ASCOSPORES 4.5–10(–11) \times (2.2–)2.5–5.5, mean 7.7 \times 3.6 ($\pm 1.2 \times \pm 0.6$) μm , L/W ratio usually >2 ($n = 200$), hyaline, broadly ellipsoid to slightly ovoid, non-septate, biseriate (sometimes tending to uniseriate) in the ascus. PARAPHYSES cylindrical, septate, clavate at the top, up to 4.5 μm wide at the apex.

DISTRIBUTION IN THE BALKANS — Bulgaria: Burgas & Sofia districts.

SPECIMENS EXAMINED: **BULGARIA**. On fallen leaves of *Laurocerasus officinalis* M. Roem. (= *Prunus laurocerasus* L.): **SOFIA REGION: Sofia distr.** SOFIA, Borisova Gradina Park alt. 592 m (42°41'N 23°19'E), 2.VI.2008 DYS (SOMF 26389), 16.VII.2008 DYS (SOMF 26400); Lozenetz Estate—19 Gorski Patnik str. 13.XII.2008 BA (SOMF 26919); **STRANDZHA Mt: Burgas distr.** MARINA RJAKA protected area 27.V.2005 BA (SOMF 25462).

EXTRALIMITAL SPECIMEN EXAMINED: **UNITED KINGDOM. Lancashire: LANCASTER**, Ashton Memorial 18.VIII.2007 BA (SOMF 26375), on fallen leaves of *Laurocerasus lusitanica* (L.) M. Roem. (= *Prunus lusitanica* L.).



FIGURES 1–3: Ascus, paraphyses, spores and outline of the leaf.
1. *T. craterium* (SOMF 26393); 2. *T. ilicina* (SOMF 25408); 3. *T. laurocerasi* (SOMF 25462).
Scale bars = 10 µm for asci, spores and paraphyses, and = 1 cm for the leaves.

Key to *Trochila* species in Bulgaria

- 1a. On leaves of *Ilex*. Ascomata epiphyllous. Ascospores $9\text{--}13.5 \times 3.5\text{--}5.5$,
mean $11.6 \times 4.5 \mu\text{m}$, length/width ratio (L/W) usually >2 *T. ilicina*
- 1b. On leaves of *Hedera* and *Laurocerasus*. Ascomata usually hypophyllous,
rarely epiphyllous 2
- 2a (1b). On *Hedera* leaves. Ascospores $4.5\text{--}9(10) \times 2.5\text{--}5$,
mean $7.1 \times 3.9 \mu\text{m}$, L/W ratio usually <2 *T. craterium*
- 2b. On *Laurocerasus* leaves. Ascospores $4.5\text{--}10.5 \times (2.2\text{--})2.5\text{--}5.5$,
mean $7.7 \times 3.6 \mu\text{m}$, L/W ratio usually >2 *T. laurocerasi*

Discussion

Trochila species are usually (Dennis 1978) characterised by a biseriate arrangement of ascospores in the asci. However, in Bulgarian specimens the arrangement of spores in some asci appeared uniseriate, possibly resulting from studying dead asci (Baral 1992).

Although easily separated by their host specificity, the three *Trochila* species are relatively difficult to distinguish microscopically (TABLES 1–3, FIGURE 4). Spore widths are not diagnostic, as the mean values are very similar and there is considerable overlap in the $M \pm 1\sigma$ area for the three species. More useful is the spore length. In *T. ilicina* the mean ascospore length is greater than in the two other species. We have not found any data in the literature regarding the ascospore length/width ratio for European *Trochila* species. Although the ratio might well be helpful — it is usually <2 in *T. craterium* and >2 in *T. ilicina* and *T. laurocerasi* — it appears only secondarily diagnostic in view of the variation noted for all three species. In general the ascus and ascospore measurements in *T. ilicina* and *T. laurocerasi* resemble those given by Coste & Rey (1994), Nauta & Spooner (2000), and Zioło et al. (2005), and are somewhat similar to those pointed out in Phillips (1893), Dennis (1978), and Medardi (2006). The values for the Romanian specimen (SOMF 26386), however, are considerably lower. One possible explanation is that the ascomata of the Romanian collection are immature. Ascospore measurements of *T. craterium* more or less agree by those cited by Dennis (1978), Greenhalgh & Morgan-Jones (1964), Nauta & Spooner (2000), and Medardi (2006). Only in the specimen on *Hedera algeriensis* from London (SOMF 26381) are the ascospores noticeably larger. Further study is needed to explain the variability of this fungus, as also noted by Greenhalgh & Morgan-Jones (1964).

Trochila craterium is apparently not a rare fungus in Bulgaria, considering the number of the above records and the distribution of the host, which is a common native and popular ornamental plant. Instead, *T. ilicina* seems to be rather uncommon in this country. Both hosts (i.e., *Ilex aquifolium*, *I. colchica*) are rare relict species and thus protected by the law. They are relatively rarely

TABLE 1. Comparison of Bulgarian and extralimital *Trochila craterium* specimens

SPECIMENS	ASCOSPORES (μm) MEAN (S.D.)	L/W RATIO	HOST SPECIES (<i>Hedera</i>)
21490 (BG)	6–9 × 3.5–4.5 7.8 × 4 (±1.0 × ±0.4)	1.5–2.2 (2±0.2)	<i>H. helix</i>
26376 (BG)	5.5–8.5 × (2.5–)3–4 6.7 × 3.1 (±1.1 × ±0.5)	1.8–2.2 (2.1±0.4)	<i>H. helix</i>
26383 (BG)	5.5–9.5 × (2.5–)3–5 7.5 × 4 (±1.1 × ±0.9)	1.4–2.8 (2±0.4)	<i>H. helix</i>
26384 (BG)	5–8 × 3.5–5 6.7 × 4.3 (±1.0 × ±0.6)	1.2–2 (1.6±0.2)	<i>H. helix</i>
26391 (BG)	4.5–10 × 3–5 6.6 × 4.1 (±1.5 × ±0.6)	1.1–2.3 (1.6±0.3)	<i>H. helix</i>
26393 (BG)	5.5–9.5 × 2.8–5.5 7.4 × 4 (±1.0 × ±0.5)	1.4–2.4 (1.8±0.3)	<i>H. helix</i>
9854 (ROM)	4–7 × 2–3.5(–4) 5.5 × 3 (±1.0 × ±0.5)	1.2–2.4 (1.9±0.3)	<i>H. helix</i>
6163 (HUN)	6.5–10 × 3.5–5(–6) 7.8 × 4.6 (±1.0 × ±0.9)	1.4–2.1 (1.7±0.2)	<i>H. helix</i>
26381 (UK)	8.5–12 × 4.5–6 9.7 × 5.1 (±1.1 × ±0.6)	1.6–2.2 (1.9±0.2)	<i>H. algeriensis</i>
26385 (BG)	4.5–7(–8) × (2.5–)3.5–4 5.6 × 2.8 (±0.8 × ±0.4)	1.7–2.3 (2.1±0.2)	<i>H. helix</i>

TABLE 2. Comparison of Bulgarian and extralimital *Trochila ilicina* specimens

SPECIMENS	ASCOSPORES (μm)	L/W RATIO	HOST SPECIES (<i>Ilex</i>)
25408 (BG)	9–13.5 × 3.5–5.5 11. 6× 4.5 (±1.0 ×±0.4)	2–3.3 (2.6±0.4)	<i>I. aquifolium</i>
26354 (UK)	7–11 × 3–5(–5.5) 9.1 × 4 (±1.7 × ±0.8)	2–2.5 (2.3±0.2)	<i>I. aquifolium</i>
26314 (TUR)	7–16 × 3.5–5.5 11.2 × 5.1 (±2.1 × ±0.4)	1.5–3 (2.2±0.4)	<i>I. colchica</i>
26386 (ROM)	(3.5–)4–7 × (2–)2.5–4(–4.5) 5.8 × 2.9 (±0.8 ×±0.5)	1.2–2.8 (2±0.3)	<i>I. aquifolium</i>

TABLE 3. Comparison of Bulgarian and United Kingdom *Trochila laurocerasi* specimens

SPECIMENS	ASCOSPORES (μm)	L/W RATIO	HOST SPECIES (<i>Laurocerasus</i>)
25462 (BG)	4.5–9 × 2.5–5.5 6.9 × 3.8 (±1.2 × ±0.7)	1.4–2.3 (1.8±0.3)	<i>L. officinalis</i>
26375 (UK)	5–11 × 3–5.5 8.5 × 3.9 (±1.3 × ±0.7)	1.8–2.9 (2.2±0.3)	<i>L. lusitanica</i>
26389 (BG)	5–10 × 2.5–4.5 7.8 × 3.3 (±1.2 × ±0.5)	1.2–3.3 (2.4±0.4)	<i>L. officinalis</i>
26919 (BG)	6–8.5 × 2.2–3.5 7.5 × 2.6 (±0.7 × ±0.4)	2.2–3.3 (2.7±0.4)	<i>L. officinalis</i>

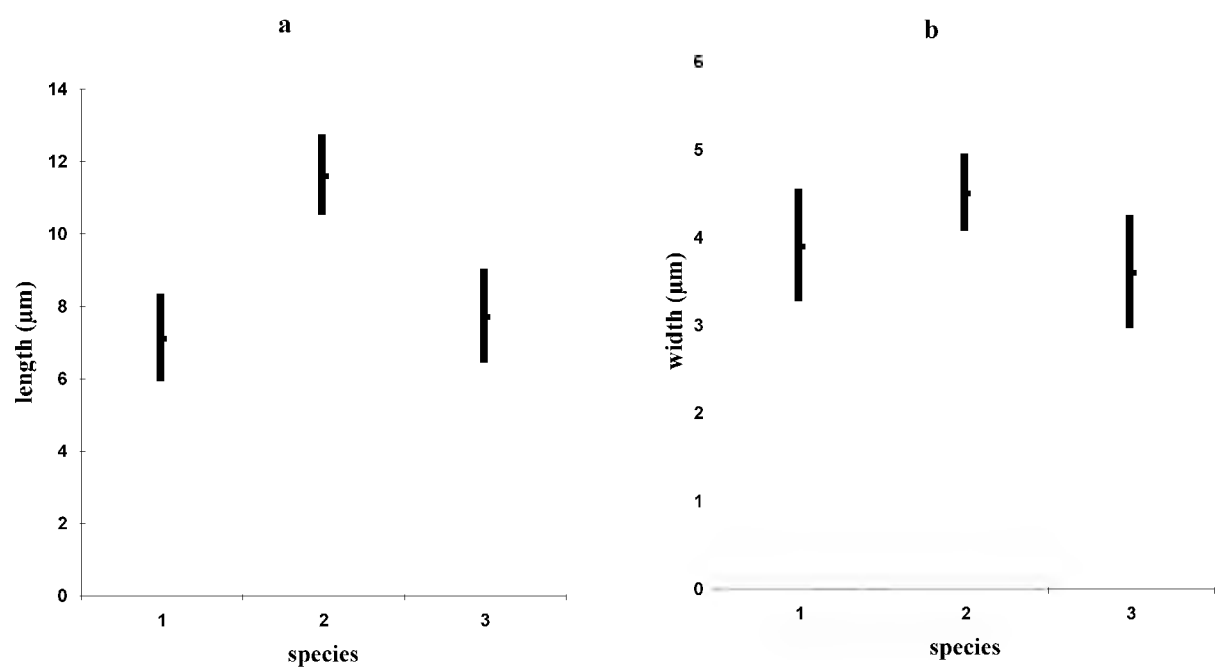


FIGURE 4. Variation of length (a) and width (b) measurements of the ascospores:
1. *T. craterium*; 2. *T. ilicina*; 3. *T. laurocerasi*.

found in gardens and the authors know of few places where they are successfully grown. Furthermore *T. ilicina* has not been seen every year even in holly's natural habitats. Denchev & Bakalova (2002) discussed the need for evaluating the threatened status of micromycetes, pointing out that fungi on rare host plants may or may not also be rare. However, in view of the available data on *T. ilicina*, it seems likely that the fungus is also a threatened species.

Trochila laurocerasi, does not appear equally threatened. Its host plant is also a preglacial relict, but although quite rare in wild in Bulgaria, it is extensively planted nearly everywhere. Though *T. laurocerasi* has been found only once in wild and twice on planted cherry laurel, it seems logical to think it is more widespread, given the numerous records on *Laurocerasus officinalis* in Slovakia (Juhásová et al. 2003) and on both *L. officinalis* and *L. lusitanica* in the United Kingdom (Ainsworth 1950, Greenhalgh & Morgan-Jones 1964, Nauta & Spooner 2000). Both host plants are non-native to those countries, so one could conclude that *T. laurocerasi* is probably a somewhat adaptable species. It is difficult to say at this point whether *T. laurocerasi* should qualify as threatened in Bulgaria.

It seems probable that *Trochila* species are sometimes overlooked. *Trochila craterium* could be relatively widespread and thus should be looked for in other neighbouring Balkan countries such as Albania, Greece, Turkey, FYR Macedonia, and Serbia. *Trochila ilicina* (as well as the two other species) tends to follow the distribution of the host plants (*Ilex aquifolium* and *I. colchica*),

and in Europe *I. aquifolium* extends to northern Germany and Austria. In the Balkans this plant is known to grow in the neighbouring countries and the fungus could be expected from Albania, FYR Macedonia, Serbia. The other European host, *I. colchica* is found in Bulgaria and Turkey. *Trochila laurocerasi* may thus also be more widely distributed in the Balkan Peninsula and could be expected elsewhere in Albania, Greece, Serbia, FYR Macedonia, Turkey, and Romania.

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Literature cited

- Ainsworth GC. 1950. The Belfast Foray. Trans. Brit. Mycol. Soc. 33: 182–188.
- Baral HO. 1992. Vital versus herbarium taxonomy: morphological differences between living and dead cells of ascomycetes, and their taxonomic implications. Mycotaxon 44: 333–390.
- Bontea V. 1985. [Parasitic and saprophytic fungi of Romania]. Vol. 1. București, Editura Academiei Române. (In Romanian)
- Coste C, Rey H. 1994. Contribution à l'étude des ascomycètes du Tarn (France, 81) 2^{ème} note. Bull. Soc. Castraise Sci. Nat. 1994: 125–148.
- Courtecuisse R, Priou J-P, Boisselet P. 1986. Contribution à la connaissance de la flore fongique du Morbihan et de quelques départements voisins – I. Doc. Mycol. 16: 1–22.
- Denchev CM, Bakalova GG. 2002. [Centenary review of the Fungal diversity investigations in Bulgaria. Sofia, Bulgarian-Swiss Biodiversity Conservation Programme]. (In Bulgarian)
- Dennis RWG. 1978. British Ascomycetes. 2nd ed. Vaduz, J. Cramer.
- Dimitrova E. 1997a. Discomycetous fungi from Belasitsa mountain. God. Sofiisk. Univ. Biol. Fak. 88: 58–60.
- Dimitrova EG. 1997b. Discomycetes new to Bulgaria. Bocconea 5: 845–848.
- Greenhalgh GN, Morgan-Jones G. 1964. Some species of *Trochila* and an undescribed Discomycete on leaves of *Prunus laurocerasus*. Trans. Brit. Mycol. Soc. 47: 311–320.
- Juhásová G, Ivanová E, Bernadovicová S, Adamčíková K, Kobza M. 2003. [Parasitic microscopic fungi – originators of diseases and damage of ornamental woody plant species]. 171–173, in S Bernadovicová (ed.), Proceedings from conference “Dreviny vo verejnej zeleni”, 27–28 May 2003. Košice. Slovakia, Botanical Garden of P.J. Safarik University. (In Slovakian)
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. (eds) 2008. Dictionary of the Fungi. 10th ed. Wallingford, CAB International.
- Lumbsch HT, Huhndorf SM (ed.). 2007. Outline of *Ascomycota* – 2007. Myconet 13: 1–58.
- Medardi G. 2006. Atlante fotografico degli Ascomiceti d'Italia. Vicenza, A.M.B Fondazione Centro Studii Micologici.

- Nauta MM, Spooner BM. 2000. British *Dermateaceae*: 4 B. *Dermateoideae* Genera G–Z. Mycologist 14: 65–74.
- Pantidou ME. 1973. Fungus-Host Index for Greece. Athens, Benaki Phytopath. Inst. Kiphissia.
- Phillips W. 1893. A Manual of the British Discomycetes with descriptions of all the species of fungi hitherto found in Britain included in the family and illustrations of the genera. 2nd ed. The International Scientific Series, vol. 61. London, Kegan Paul, Trench, Thübner & Co. Ltd.
- Stoykov DY, Denchev CM. 2007. New records of non-lichenized ascomycetes from Mt. Strandzha in Turkey (south-eastern Europe). Mycol. Balcan. 4: 157–159.
- Zioło EM, Madej T, Blaszkowski J. 2005. *Trochila ilicina* (*Helotiales*, *Ascomycota*), a fungus newly found in Poland. Acta Mycol. 40: 181–184.

***Grammothele* species from southern Brazil**

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Abstract — Three species of *Grammothele* found in Rio Grande do Sul State in southern Brazil — *G. fuligo*, *G. lineata*, *G. subargentea* — are described and illustrated. *Grammothele fuligo* is recorded for the first time from extra-Amazonian Brazil. The genus produces resupinate basidiomata with bluish-gray to dark-gray pore surfaces and with very shallow pores; microscopically, it is diagnosed by a dimitic hyphal system, clamped generative hyphae, dextrinoid skeletal hyphae, and abundant dendrohyphidia.

Key words — *Grammotheleaceae*, resupinate polypore, Brazilian Atlantic Rain Forest

Introduction

The genus *Grammothele* was described by Berkeley & Curtis (1868) and was historically classified in the *Corticaceae* s. lat. based on its effused basidiomata with poorly developed, irregular pores and a hymenium restricted to the basal part of the tubes (Ryvarden 1992). Kirk et al. (2008) include the genus in the family *Grammotheleaceae* Jülich (1981), citing eight pantropical species. Larsson (2007), however, places *Grammothele* in *Polyporaceae* based on its dimitic hyphal system and supported by *Grammothele fuligo* DNA sequence analyses.

According to Ryvarden & Johansen (1980), the genus is related to *Theleporus* Fr., a resupinate genus that also has shallow tubes with the hymenia restricted to tube bases and dendrohyphidia but which differs from *Grammothele* in having a di- to trimitic hyphal system with dendroid skeletal or binding hyphae. *Porogramme* (Pat.) Pat. is also very similar but lacks dendrohyphidia. *Tinctoporellus* Ryvarden, a genus that shares macro and micro morphology and culture features (Rajchenberg 1983), can be also confused with *Grammothele*; however, in *Tinctoporellus* the hymenophore is distinctly tubular and the dendrohyphidia are absent.

Knowledge of the genus in Brazil is poor: Rick (1938) described *Grammothele ceracea* from Rio Grande do Sul State, but Rajchenberg (1987a) considered it a nomen dubium. Rick (1960) also recorded *G. lineata* and *G. subargentea*

(as *Poria hydnopora* (Berk.) Sacc. and *Poria subargentea* Speg., respectively). Lowe (1964) cited *G. delicatula* from southeast Brazil, but this species is now placed in the genus *Dichomitus* (Masuka & Ryvar den 1999). Several authors since Rick (Rajchenberg & Meijer 1990, Jesus 1996, Jesus et al. 1998, Ryvar den & Meijer 2002, Gibertoni et al. 2004, Drechsler-Santos et al. 2008) have recorded *Grammothele* taxa from Brazil, but none provide keys, descriptions, or illustrations.

A key, descriptions, and comparisons among *Grammothele* species from southern Brazil are presented below. The studied specimens were collected in the Atlantic Rain Forest, which covers the low to medium elevations of the eastern slopes of the mountain formation along the coast from southern to northeastern Brazil and which is characterized by a high mean temperature and constant high precipitation throughout the year (Morellato & Haddad 2000).

Materials and methods

Basidiomes were collected along the north coast of Rio Grande do Sul State in the austral limit of the Atlantic Rain Forest in forests remnants extending between 29°12'–24'S and 49°42'–50°07'W. Additional specimens of *Grammothele subargentea* from other regions of the State were also examined. Macro- and microscopic analyses followed procedures set forth by Núñez & Ryvar den (2001). Microscopic examination was made from freehand sections mounted drops of 5% KOH mixed with 1% phloxine solution; amyloid or dextrinoid reactions were observed in Melzer's reagent. Specimens were identified using keys and descriptions by Rajchenberg (1984) and Ryvar den & Johansen (1980). Description abbreviations are modified from Coelho (2005), with Pm = pore average, Dm = diameter mean, Lm × Wm = means of length and width, Q = range of length/width ratios, Qm = length/width mean, and n = x/y (with x = number of measurements from a given number (y) of specimens). Color names and codes are from Kornerup & Wanscher (1978). All the specimens are preserved at the Botany Department Herbarium, Universidade Federal do Rio Grande do Sul (ICN).

Taxonomy

Key to *Grammothele* species in Brazil

- 1. On decayed monocotyledons (especially palms); pores 5–11/mm 1. *Grammothele fuligo*
- 1'. On decayed dicotyledons, pores 2–4/mm 2
- 2. Tubes very shallow, ≤ 200 µm deep, encrusted brown hyphal pegs present in hymenium and subiculum, basidiospores ellipsoid, 4.5–6.0 × 2.5–3.0 µm 2. *G. lineata*
- 2'. Tubes deeper, ≤ 0.7 mm deep, hyphal pegs lacking, basidiospores cylindrical to ellipsoid ~6.5–8.5 × 3–4 µm 3. *G. subargentea*

Descriptions

1. *Grammothele fuligo* (Berk. & Broome) Ryvarden

Transactions of the British Mycological Society 73: 15, 1979. FIGS 1–6, 20

BASIDIOMATA annual, resupinate, widely effused, strongly adnate, ceraceous when fresh, becoming hard and brittle; margin wide to narrow, greyish violet (17.C4). Pore surface dark violet (17.F4; 18.D5), dull violet (18.D4) to grayish violet (18.E5; 19.D6); pores regular and angular, with thin and entire dissepiments, invisible to the naked eye, 5–11/mm, $Pm = 8.47$, $n = 60/2$. Tubes very shallow, up to 0.5 mm deep, subiculum dark brown and very thin, up to 50 μm thick.

HYPHAL SYSTEM dimitic. Generative hyphae hyaline, with clamps, thin walled, 1.0–3.0 μm wide, $Dm = 1.93$, $n = 90/3$, much branched, abundant near the hymenium; skeletal hyphae dominating in context and tube walls, thick-walled to almost solid, strongly dextrinoid, 2–5 μm wide, $Dm = 3.45$, $n = 90/3$, unbranched or rarely with some branches, parallelly arranged in the trama. Dendrohyphidia present, abundant along the pore edges, arising from generative hyphae, strongly branched in the apices, also observed along the sterile walls of the pores. HYMENIUM without cystidia. Basidia clavate, tetraspored, with large sterigmata, $19\text{--}23 \times 5\text{--}7 \mu m$. Basidiospores cylindrical to narrowly ellipsoid, sometimes slightly curved, hyaline, thin-walled, smooth and non dextrinoid, $(5.5\text{--})6\text{--}8 \times 3\text{--}3.5 \mu m$, $Lm \times Wm = 6.57 \times 3.10$, $Q = 1.83\text{--}2.67$, $Qm = 2.14$, $n = 90/3$.

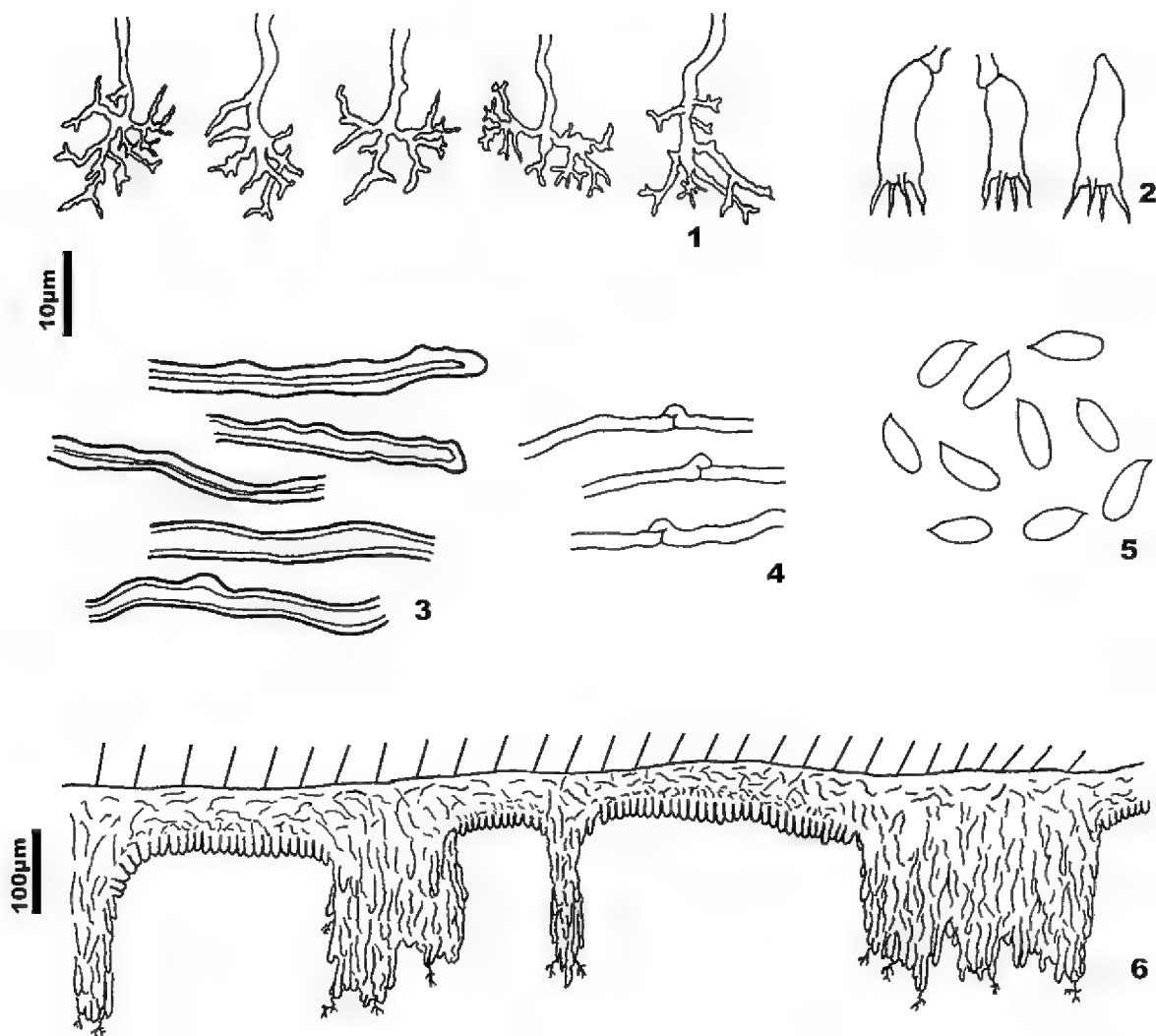
CULTURAL CHARACTERISTICS. Unknown.

HABITAT. On decayed monocotyledons, found on the decayed palms of *Syagrus romanzoffiana* (Cham.) Glassman and *Euterpe edulis* Mart. (Arecaceae). According to Ryvarden & Johansen (1980) and Coelho et al. (2006) this species can also be found on bamboo species. Causing a white wood-rot in the hosts.

DISTRIBUTION. Pantropical, previously known only from tropics following the distribution of palms from East Africa (Ryvarden & Johansen 1980), China (Dai et al. 2004), India (Virdi 1990), Jamaica (Ryvarden 2000), Japan (Nuñez & Ryvarden 2001), Venezuela (Iturriaga & Ryvarden 2001), Hawaii (Gilbertson et al. 2002), Belize (Ryvarden 2007), and Brazil (Roraima, Jesus 1996; Amazonas, Jesus et al. 1998). This is the first record of *Grammothele fuligo* from a subtropical biome.

SPECIMENS EXAMINED: BRAZIL. Rio Grande do Sul State, municipality of Dom Pedro de Alcântara, Mato da Cova Funda, 16.XII.2007, leg. M.A. Reck 126/07 (ICN 139976); municipality of Morrinhos do Sul, Lajeadozinho, 04.VII.2008, leg. M.A. Reck 076/08 (ICN 154190); leg. M.A. Reck 077/08 (ICN 154191); leg. M.A. Reck 078/08 (ICN 154192).

REMARKS. This species is usually easy to recognize in the field because of its association with monocotyledons and blue grayish colour. At first sight, this



FIGS. 1–6. Microscopic characters of *Grammothele fuligo*.

1. Dendrohyphidia. 2. Basidiospores. 3. Skeletal hyphae. 4. Generative hyphae.
5. Basidia. 6. Longitudinal section of the basidiome.

fungus resembles a *Corticaceae* species, but under the lens it shows very shallow pores on a very thin basidiomata. *Grammothele fuligo* can be separated from *G. lineata* and *G. subargentea* mainly by the specific host and small pores. *Porogramme albocincta* (Cooke & Masee) J. Lowe (Ryvarden & Johansen 1980), which might be confused with *G. fuligo* due to the similar basidiome color, grows on dicot wood and lacks dendrohyphidia. Some pinkish coloured resupinate species of *Junghuhnia* Corda, such as *J. meridionalis* (Rajchenb.) Rajchenb. (Rajchenberg 1987b), which has very small pores and a waxy consistency, is also macroscopically similar to *G. fuligo* but can be distinguished by its encrusted thick-walled hymenial cystidia, non-dextrinoid skeletal hyphae, and reddish brown basidiome colour. Our specimens differed from the East African specimens described by Ryvarden & Johansen (1980) by larger (5–11/mm vs. 8–16/mm) pores and shorter [(5.5–)6–8 µm vs. 7–9 µm] basidiospores.

As noted by Ryvar den & Johansen (1980), *G. fuligo* is found in forests only where palm and/or bamboo is abundant. The studied area contains the richest palm and bamboo habitats in Rio Grande do Sul State (Rambo 1950).

This is the first record of *G. fuligo* from Rio Grande do Sul State.

2. *Grammothele lineata* Berk. & M.A. Curtis

Journal of the Linnean Society, Botany 10: 327, 1868.

FIGS 7–13, 21

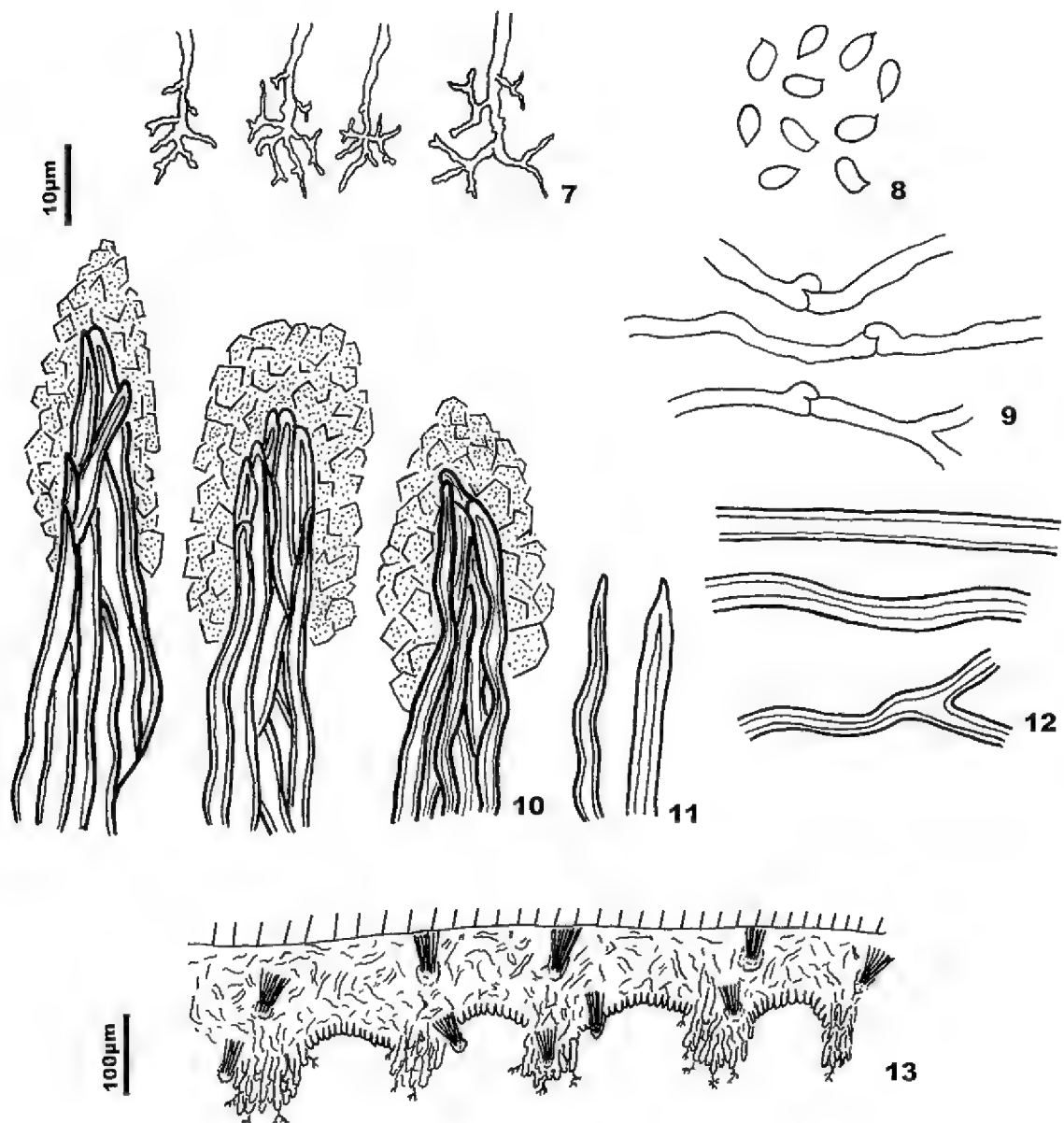
BASIDIOMATA annual, resupinate, strongly adnate, hard and brittle, thin, up to 0.3 mm thick, with reticulate furrows; sterile margin thin, reddish lilac (14.B3) to purplish grey (14.B2), regular and farinose; pore surface violet grey (18.B2; 18.C2) to greyish violet (18.C3), also greyish lilac (15.C2), finely spotted with dark points here and there; pores irregular, angular and very shallow, (2–)3–4 (–5)/mm, $Pm = 3.53$, $n = 60/2$, with irregular dissepiments, that occur in a teeth pattern, or in labyrinth form, tube layer very thin, 200 μm thick; subiculum very thin, up to 180 μm wide, concolorous with the pore surface, becoming darker with age.

HYPHAL SYSTEM dimitic. Generative hyphae with clamps, hyaline and thin-walled, branched and tortuous, 1.0–2.5 μm wide, $Dm = 1.68$, $n = 90/3$, difficult to find in dried specimens; skeletal hyphae hyaline to pale brown in KOH solution, thick-walled to solid, straight to regularly branched and, in that case resembling binding hyphae, dextrinoid, strongly dextrinoid in mass, 1.5–3.5 μm wide, $Dm = 2.33$, $n = 90/3$; after drying the hyphal structure becomes agglutinated and very difficult to separate. Hyphal pegs triangular, present in all the basidiomata, arising from the trama or the subiculum, constituted by parallel and unbranched skeletal hyphae with sword-like apices, with a yellowish brown tint, mostly encrusted by crystals, 55–110 \times 10–30 μm , $Lm \times Wm = 75.30 \times 21.37$, $Q = 2.60$ –6.20, $Qm = 3.68$, $n = 90/3$. **HYMENIUM** without cystidia. Dendrohyphidia abundant, present in the hymenium and dissepiments, hyaline, very sinuous and branched, arising from the generative hyphae, difficult to find when dried. Basidia clavate, tetraspored, 10.5–16 \times 3–6 μm . Basidiospores ellipsoid to narrowly ellipsoid, rarely cylindric, hyaline, smooth and thin-walled, IKI–, 4.5–6.0 \times 2.5–3.0 μm , $Lm \times Wm = 5.20 \times 2.83$, $Q = 1.50$ –2.20, $Qm = 1.84$, $n = 90/3$.

CULTURAL CHARACTERISTICS. See David & Rajchenberg (1985). Causing a white wood-rot.

SUBSTRATA: on decayed angiosperm branches.

DISTRIBUTION: Pantropical, widely distributed. Recorded from Argentina (Rajchenberg 1984, Wright & Wright 2005), Costa Rica (Carranza & Ryvar den 1998), Panama (Nuñez & Ryvar den 1999), East Africa (Ryvar den & Johansen 1980), Taiwan (Lin & Chen 1990), and Venezuela (Iturriaga & Ryvar den 2001).



FIGS. 7–13. Microscopic characters of *Grammothele lineata*.

7. Dendrohyphidia. 8. Basidiospores. 9. Generative hyphae. 10. Encrusted hyphal pegs. 11. Sword like skeletal hyphae. 12. Skeletal hyphae. 13. Longitudinal section of the basidiome.

Cited previously from Brazil from the States of Rio Grande do Sul (Rick 1960), Roraima (Jesus 1996), Alagoas, and Pernambuco (Gibertoni et al. 2004).

SPECIMENS EXAMINED: BRAZIL. RIO GRANDE DO SUL STATE, municipality of Dom Pedro de Alcântara, Mato da Cova Funda, 16.XII.2007, leg. M.A. Reck 121/07 (ICN 139971); municipality of Morrinhos do Sul, Perdida, 23.II.2008, leg. M.A. Reck 014/08 (ICN 154011); Lajeadozinho, 04.VII.2008, leg. M.A. Reck 075/08 (ICN 154189).

REMARKS: *Grammothele lineata* is macroscopically characterized by tubes so shallow that the basidiomata may be confused with smooth (i.e., poreless) corticioid fungi and by the grayish pink tint of the hymenial surface. Microscopically, it is unmistakable vis à vis other *Grammothele* species due to

the presence of encrusted and darkened hyphal pegs and ellipsoid basidiospores. Upon drying, the hyphal pegs may appear as small dark points in the tubes. Basidiospores of our materials measure slightly wider (2.5–3.0 μm) than those described by Ryvarden & Johansen (1980; 1.5–2.5 μm). Lin & Chen (1990) describe the encrusted hyphal pegs as shaped like pine trees.

This species was frequent and quite easy to find in the studied area, appearing mainly inside the forest.

3. *Grammothele subargentea* (Speg.) Rajchenb.

Mycotaxon 17: 280, 1983.

FIGS 14–19, 22

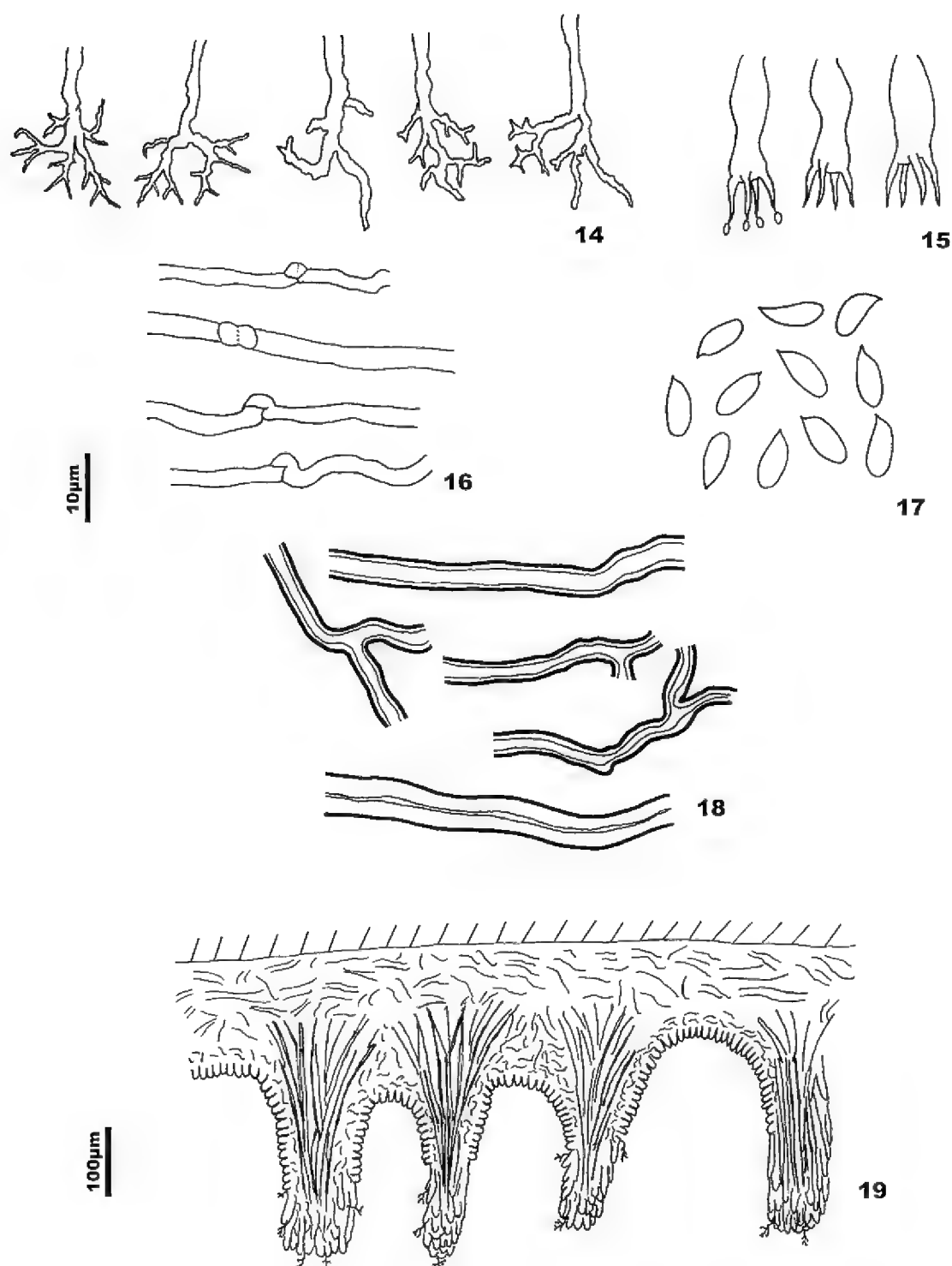
BASIDIOMATA annual, resupinate, adnate, totally effused, gelatinous to corky when fresh, becoming hard upon drying; margin irregular, lilac (15.B4) to pastel violet (15.A4), thin and farinose; pore surface reddish violet (16.B8), also reddish lilac (14.C4) to greyish lilac (16.C2), with regular and angular pores, 2–4/mm, $Pm = 2.87$, $n = 60/2$, dissepiments entire and thin, tubes shallow, up to 0.7 mm deep; subiculum very thin, up to 100 μm thick, reddish, becoming darker with age.

HYPHAL SYSTEM dimitic. Generative hyphae with clamps, hyaline and thin-walled, much branched and difficult to find in dried specimens, 1.0–2.5 μm wide, $Dm = 1.75$, $n = 90/3$; skeletal hyphae pale yellow to cinnamon in KOH sol., thick-walled, scarcely branched, sinuous to straight, abundant, strongly dextrinoid, 1.5–4.0 μm wide, $Dm = 2.75$, $n = 90/3$. Dendrohyphidia abundant in the fresh specimens, occurring both in the dissepiment edges and hymenium, arising from generative hyphae, hyaline, very branched and sinuous. **HYMENIUM** without cystidia. Basidia clavate, tetraspored, $14\text{--}20 \times 4\text{--}6 \mu\text{m}$. Basidiospores cylindric, rarely subellipsoid, hyaline, smooth and thin-walled, $(6\text{--})6.5\text{--}8.5 \times (-2.5)3\text{--}4 \mu\text{m}$, $Lm \times Wm = 7.45 \times 3.37$, $Q = 1.88\text{--}2.67$, $Qm = 2.23$, $n = 90/3$.

CULTURAL CHARACTERISTICS. See Rajchenberg (1983) and David & Rajchenberg (1985). Causing a white wood-rot.

SUBSTRATA: on decayed wood of angiosperms.

DISTRIBUTION: South America and East Africa (Rajchenberg 1984). In the Neotropics, *G. lineata* has been reported from both in subtropical and tropical areas in Argentina (Rajchenberg 1984, Wright & Wright 2005, Robledo & Rajchenberg 2007), Belize (Ryvarden 2007), Paraguay (Popoff & Wright 1998), and Venezuela (Iturriaga & Ryvarden 2001). In Brazil, it was previously recorded from the States of Rio Grande do Sul (Rick 1960, Reck & Silveira 2008), Roraima (Jesus 1996), Paraná (Rajchenberg & Meijer 1990, Ryvarden & Meijer 2002), Alagoas, Pernambuco, Paraíba (Gibertoni et al. 2004), and Santa Catarina (Drechsler-Santos et al. 2008). *Grammothele lineata* was easily found in the study area, fruiting mainly on decayed wood inside the forest.



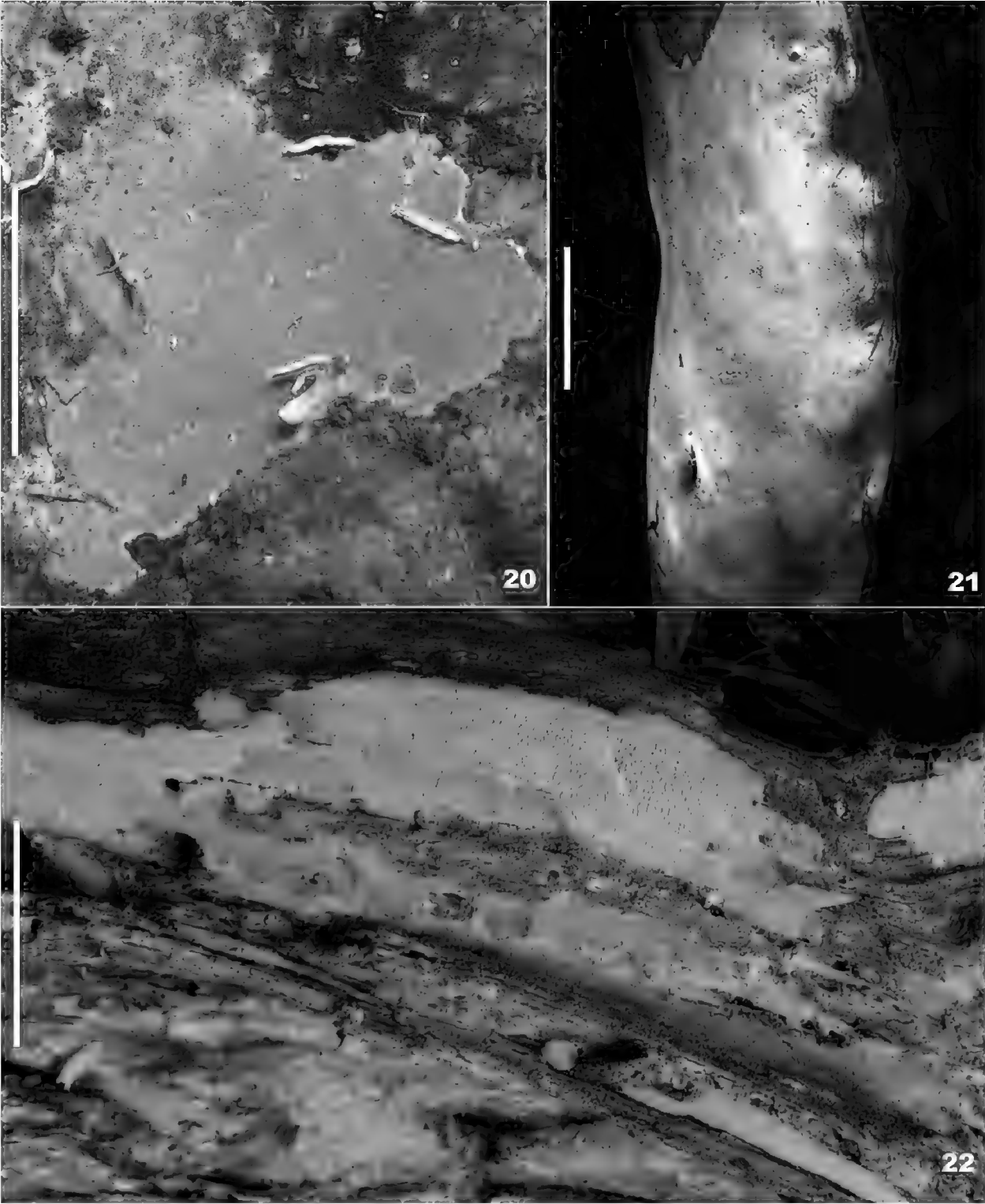
FIGS. 14–19. Microscopic characters of *Grammothele subargentea*.
 14. Dendrohyphidia. 15. Basidiospores. 16. Basidia. 17. Generative hyphae.
 18. Skeletal hyphae. 19. Longitudinal section of the basidiome.

SPECIMENS EXAMINED: BRAZIL. Rio Grande do Sul State, municipality of Dom Pedro de Alcântara, Mato da Cova Funda, 27.III.2007, leg. M.A. Reck 017/07 (ICN 139884); 25.XI.2007, leg. M.A. Reck 118/07 (ICN 139968); 16.XII.2007, leg. M.A. Reck 145/07 (ICN 139995); M.A. Reck 146/07 (ICN 139996); municipality of Mampituba, Silveirão, 17.IV.2007, leg. M.A. Reck 051/07 (ICN 139904); 15.IV.2007, leg. M.A. Reck 090/07 (ICN 139940).

ADDITIONAL MATERIAL: BRAZIL. Rio Grande do Sul State, municipality of Viamão, 16.IV.2005, leg. M.A. Reck 033/05 (ICN 139214); 21.XI.2003, leg. M.A. Reck 033/05 (ICN

139233); municipality of Porto Alegre, Morro Santana, 14.XII.2007, leg. M.C. Westphalen
077/07 (ICN 154129)

REMARKS: The vivid pink colour of the fresh basidiomata characterizes this species. In comparison with *Grammothele fuligo* and *G. lineata*, *G. subargentea* alone possesses a hymenium that can cover the vertical sides of the tubes. Rajchenberg (1983) cites its abundant dendrohyphidia, cylindric basidiospores,



FIGS. 20–22. Basidiomes of *Grammothele*.
20: *G. fuligo*. 21: *G. lineata*. 22. *G. subargentea*.
Scale bars = 5 cm.

and dextrinoid skeletal hyphae as features sufficient to include it in *Grammothele*. *Gloeoporus dichrous* (Fr.) Bres. (Gilbertson & Ryvarden 1986) and *Skeletocutis roseola* (Rick ex Theiss.) Rajchenb. (Silveira & Guerrero 1991) have a similarly colored pore surface, but both can be separated based on their effuse-reflexed basidiomes and minute ($<2\ \mu\text{m}$ diam) allantoid spores. Our material agrees with Rajchenberg's (1984), observation that the substrate generally shows a reddish line near the basidiome margin, somewhat similar to *Tinctoporellus epimiltinus* (Berk. & Broome) Ryvarden, a resupinate greyish species that reddens the substrata (Rajchenberg 1984) but that lacks dendrohyphidia and has smaller ($\leq 9/\text{mm}$) pores (Ryvarden & Johansen 1980). Molecular studies may be necessary to clarify the relationship between the two species, as *G. subargentea* and *T. epimiltinus* also have similar culture features (Rajchenberg 1983).

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Literature cited

- Berkeley MJ, Curtis MA. 1868. Fungi cubenses (Hymenomycetes). Journal of the Linnean Society, Botany 10: 280–392.
- Carranza J, Ryvarden L. 1998. Additional list of pore fungi of Costa Rica. Mycotaxon 69: 377–390.
- Coelho G. 2005. A Brazilian new species of *Auriporia*. Mycologia 97: 266–270.
- Coelho G, Silveira RMB, Rajchenberg M. 2006. A new *Gloeoporus* species growing on bamboo from southern Brazil. Mycologia 98(5): 821–827.
- Dai YC, Wei YL, Zhang XQ. 2004. An annotated checklist of non-poroid *Aphylllophorales* in China. Annales Botanici Fennici 41(4): 233–247.
- David A, Rajchenberg M. 1985. Pore fungi from French Antilles and Guiana. Mycotaxon 22(2): 285–325.
- Drechsler-Santos ER, Groposo C, Loguercio-Leite C. 2008. Additions to the knowledge of lignocellulolytic basidiomycetes in forests from Santa Catarina, Southern Brazil. Mycotaxon 103: 197–200.
- Gibertoni TB, Ryvarden L, Cavalcanti MAQ. 2004. Poroid fungi (*Basidiomycota*) of the Atlantic Rain Forest in Northeast Brazil. Synopsis Fungorum 18: 33–43.
- Gilbertson RL, Bigelow DM, Hemmes DE, Desjardín DE. 2002. Annotated check list of wood-rotting *Basidiomycetes* of Hawaii I. Mycotaxon 82: 215–239.
- Gilbertson RL, Ryvarden L. 1986. North American polypores. *Abortiporus – Lindtneria*. Oslo, Fungiflora, v.1, 433pp.
- Iturriaga T, Ryvarden L. 2001. Studies in neotropical polypores 9. A critical checklist of poroid fungi from Venezuela. Mycotaxon 78: 393–405.
- Jesus MA. 1996. Contribution to the knowledge of wood-rotting fungi in Brazil. II. Checklist of fungi from Maracá Island, Roraima State. Mycotaxon 57: 323–328.

- Jesus MA, Morais JW, Abreu RLS, Cardias MFC. 1998. Durabilidade natural de 46 espécies de Madeira amazônica em contato com o solo em ambiente florestal. *Scientia Florestalis* 54: 81–92.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Ainsworth and Bisby's dictionary of the fungi. 10th Edition, CABI Publishing.
- Kornerup A, Wanscher JH. 1978. Methuen handbook of colour. 3rd ed. London (UK): Eyre Methuen.
- Larsson KH. 2007. Re-thinking the classification of corticioid fungi. *Mycological Research* 111: 1040–1063.
- Lin SH, Chen ZC. 1990. The *Corticaceae* and the resupinate *Hydnaceae* of Taiwan. *Taiwania* 35(2): 69–111.
- Lowe JL. 1964. The genera *Grammothele* and *Porogramme*. *Papers Mich. Acad. Sci., Arts Lett.* 49: 27–40.
- Masuka AJ, Ryvardeen L. 1999. *Dichomitus* in Africa. *Mycological Research* 103(9): 1126–1130.
- Morellato LPC, Haddad CFB. 2000. Introduction: the Brazilian Atlantic Forest. *Biotropica* 32(4b): 786–792.
- Núñez M, Ryvardeen L. 1999. Studies in neotropical polypores 4. New and noteworthy species from Coiba National Park, Panama. *Mycotaxon* 71: 361–367.
- Núñez M, Ryvardeen L. 2001. East Asian polypores. *Oslo: Synopsis Fungorum* 13(1): 1–168.
- Popoff OF, Wright JE. 1998. Fungi of Paraguay. I. Preliminary check-list of wood-inhabiting Polypores (*Aphylllophorales*, *Basidiomycota*). *Mycotaxon* 67: 323–340.
- Rajchenberg M. 1983. Cultural studies of resupinate polypores. *Mycotaxon* 17: 275–293.
- Rajchenberg M. 1984. Basidiomicetos xilófilos de la Región Mesopotámica, República Argentina V. Políporos resupinados. *Revista de Investigaciones Agropecuarias, INTA* 19: 1–105.
- Rajchenberg M. 1987a. Type studies of *Polyporaceae* (*Aphylllophorales*) described by J. Rick. *Nordic Journal of Botany* 7(5): 553–568.
- Rajchenberg M. 1987b. Xylophilous *Aphylllophorales* (*Basidiomycetes*) from the southern Andean forests. Additions and corrections II. *Sydowia* 40: 235–249.
- Rajchenberg M, Meijer AAR. 1990. New and noteworthy polypores from Paraná and São Paulo Sates, Brazil. *Mycotaxon* 38: 173–185.
- Rambo B. 1950. A porta de Torres. *An. Bot. Herb. Barb. Rodr* 2(2): 8–20.
- Reck MA, Silveira RMB. 2008. Ordem *Polyporales* (*Basidiomycota*) no Parque Estadual de Itapuã, Viamão, Rio Grande do Sul. *Revista Brasileira de Biociências* 6(3): 301–314.
- Rick J. 1938. Monografia das poliporíneas Riograndenses. *Broteria Ser. Cienc. Nat* 7: 5–21.
- Rick J. 1960. *Basidiomycetes* Eubasidii in Rio Grande do Sul – Brasília 4. *Meruliaceae, Polyporaceae e Boletaceae*. *Iheringia Série Botânica* 7: 193–295.
- Robledo GL, Rajchenberg M. 2007. South American polypores: first annotated checklist from Argentinean Yungas. *Mycotaxon* 100: 5–9.
- Ryvardeen L. 1992. Genera of Polypores: Nomenclature and taxonomy. *Synopsis Fungorum* 5: 1–363.
- Ryvardeen L. 2000. Studies in neotropical polypores 8: poroid fungi from Jamaica – a preliminary check list. *Mycotaxon* 76: 349–360.
- Ryvardeen L. 2007. Studies in neotropical polypores 23. new and interesting wood-inhabiting fungi from Belize. *Synopsis Fungorum* 23: 23–50.
- Ryvardeen L, Johansen I. 1980. A preliminary polypore flora of East Africa. *Oslo, Fungiflora*, 636p.
- Ryvardeen L, Meijer AAR. 2002. Studies in neotropical polypores 14. New species from the state of Paraná, Brazil. *Synopsis Fungorum* 15: 34–69.

- Silveira RMB, Guerrero RT. 1991. *Aphylophorales* poliporóides (*Basidiomycetes*) do Parque Nacional de Aparados da Serra, RS. Boletim do Instituto de Biociências 48: 1–147.
- Virdi SS. 1990. Two resupinate, wood decaying poroid fungi new to India. Sydowia 42: 209–210.
- Wright JE, Wright AM. 2005. Checklist of the mycobiota of Iguazu National Park (Misiones, Argentina). Boletín de la Sociedad Argentina de Botánica 40(1–2): 23–44.

A new subspecies of *Gyalidea asteriscus* from China¹

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Abstract — The genus *Gyalidea* is reported for the first time from China. *Gyalidea asteriscus* subsp. *gracilispora* from deserts of northern China is described as new to science. Latin diagnosis, English description, and illustrations are given for the new taxon. A new combination, *G. asteriscus* subsp. *nigrescens*, is also made.

Key words — lichens, *Asterothyriaceae*, new Chinese record, taxonomy

Introduction

During the lichen study of arid and semiarid deserts from northern China, numerous specimens of apothecia with star-shaped margins (FIGS. 2A–B) containing polysporic asci (FIG. 2F) were collected from soil and microbiotic crust in the arid land of Hebei, Shanxi, Ningxia, Gansu, and Qinghai. The lichen examined is close to both *Solorinella asteriscus* and *S. nigrescens* (Thor 1984) in habit and chemistry, but differs in its wider paraphyses, smaller asci, and narrower ascospores. *S. nigrescens* has been reduced to subspecific rank as *S. asteriscus* subsp. *nigrescens* (Vězda, Lumbsch & Øvstedal, 1990).

The genus *Solorinella* has recently been transferred to the genus *Gyalidea* based on phenotypically phylogenetic analysis, and the species *S. asteriscus* has been recombined as *G. asteriscus* (Aptroot & Lücking 2003). Our collections from the desert in China represent a new taxon, *G. asteriscus* subsp. *gracilispora*. In keeping with these recent nomenclatural changes, we transfer *Solorinella asteriscus* subsp. *nigrescens* to *Gyalidea* under the new combination, *G. asteriscus* subsp. *nigrescens*.

The lichen genus *Gyalidea* (*Asterothyriaceae*, *Ostropales*, *Ostropomycetidae*) is reported for the first time from China.

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Material and methods

The specimens studied were collected from the microbiotic crusts in the arid land of Hebei, Shanxi, Ningxia, Gansu, and Qinghai. The dissecting microscope (Leica MZ8) and compound microscope (Zeiss Axioskop 2 plus) were available for morphological and anatomical studies, and color test and standardized TLC was used for detecting of lichen substances (Culberson & Kristinssen 1970, Culberson 1972, Culberson & Johnson 1982, White & James 1985).

Taxonomy

Gyalidea asteriscus (Anzi) Aptroot & Lücking, Biblioth. Lichenol. 86: 67 (2003).
BASIONYM. *Solorinella asteriscus* Anzi, Catal. Lich. Sondr. p. 37 (1860).

Gyalidea asteriscus subsp. *gracilispora* Jun Yang & J.C. Wei, subsp. nov.

MYCOBANK MB 513530 FIGS. 1, 2.

Subspecies nova habitu et substantia cum Gyalidea asteriscus subsp. asteriscus et G. asteriscus subsp. nigrescente optime congruens, sed differt paraphysibus crassioribus, ascis brevioribus et parvulioribus, ascosporis gracilioribus.

TYPE COLLECTION: Hebei, Mt. Xiaowutai, south of Jinghekou management area, N39°56', E 114°56', alt. 1190 m, on soil, 15 April 2005, Hai-Ying Wang & Xin-Li Wei, 3058 (holotypus - HMAS-L).

ETYMOLOGY: Latin: “*gracilispora*” = narrow ascospore.

APOTHECIA with deep concave discs of dark brown to black color and of 1.1–1.8 mm in diam. bearing white star-shaped margins consisting of 4–8 triangles or cones of white lobelet. Margins star-shaped, white, paraplectenchymatous, lobelets 10–150 µm wide at top and 300–350 µm wide at bottom, 200–300 µm high; epithecium brownish, 25–30 µm thick; hymenium K–, I–, hyaline to pale brownish, 105–145µm thick; hypothecium hyaline to pale brownish, 25–35 µm high; paraphyses hyaline, unbranched, septate, 2–3 µm thick; asci cylindrical with apex structure of *Tremolecia*-type, polysporic, 52.5–72.5(–82.5)

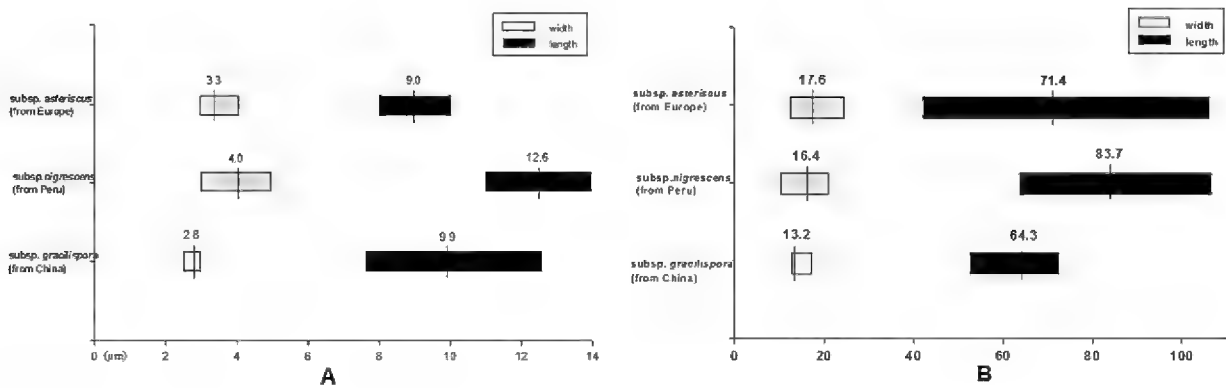


FIG. 1. Comparisons of ascospore (A) and ascus (B) size among three subspecies of *G. asteriscus*. Data for subsp. *asteriscus* and subsp. *nigrescens* are from Thor (1985, “1984”).

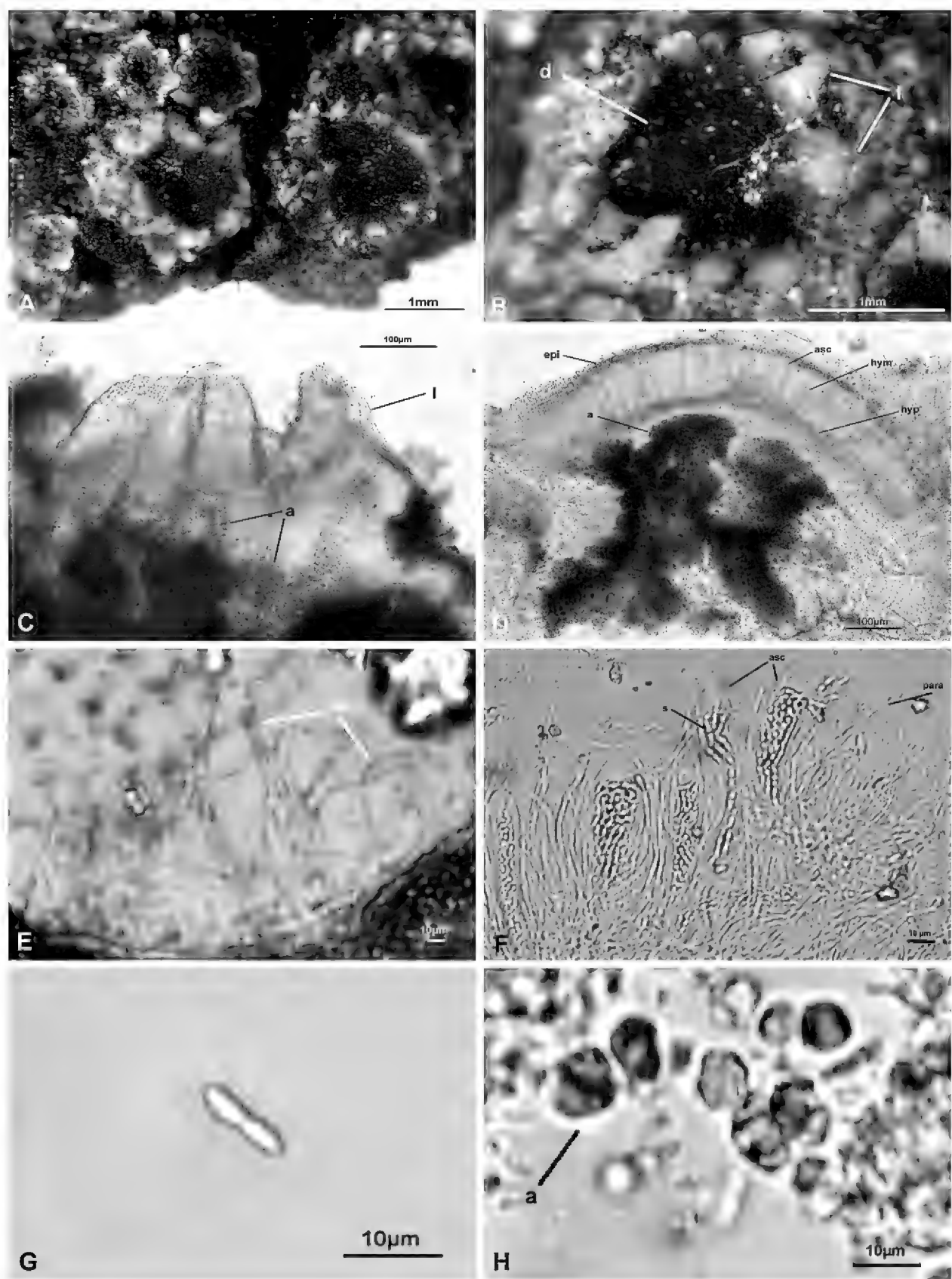


FIG. 2. A. The habit of *G. asteriscus* subsp. *gracilispora* (bar = 1 mm); B. One apothecium with star = shaped lobes at margin (bar = 1 mm); C. Cross section of a star = shaped lobe (bar = 100 μm); D. Cross section of an apothecium (bar = 100 μm); E. Septate paraphyses in cotton blue (bar = 10 μm); F. Asci containing spores (bar = 10 μm); G. An ascospore; H. Algal cells.
(a = algal cells; asc = ascus; d = disk of apothecium; epi = epithecium; hym = hymenium; hyp = hypothecium; l = lobe; para = paraphyses; s = spores)

× (10–)12.5–17.5 µm; ascospores hyaline, oblong ellipsoidal, 2-celled, 7.5–12.5(–17.5) × 2.5–3(–3.5) µm.

CONIDIOMATA not seen.

CHEMISTRY: no lichen substances detected by TLC; all parts C–, K–, KC–, PD–.

PHYCOBIONT belonging to *Chlorococcaceae*, 7.5–10 µm diameter.

HABIT: on soil of the microbiotic crusts in arid land.

ADDITIONAL SPECIMENS EXAMINED: **HEBEI**: Mt. Xiaowutai, south of Jinghekou management area, N39°56', E 114°56', alt. 1190 m, on soil, 15 April 2005, Hai-Ying Wang & Xin-Li Wei, 3041, 3043, 3052, 3053, 3056 (HMAS-L); Fengning County, Xiaobazi Village, on soil, 24 April 2004, XBZ038 (HMAS-L). **SHANXI**: Yanggao County, Xiejiatun Village, on soil, Jun Yang & Tao Zhang, 23 September 2004, SX039 (HMAS-L). **NINGXIA**: Zhongwei, Shapotou, on microbiotic crust, 6 August 2003, Jiang-Chun Wei & Jun Yang, SPT372 (HMAS-L). **GANSU**: Weiyuan County, Mt. Junshan, 28 October 2004, on soil, En-Ran Zhang, GS055, GS067 (HMAS-L). **QINGHAI**: Gonghe County, Qiabuqia, alt. 2910 m, on soil, 10 September 2005, Man-Rong Huang & Jun Yang QH030 (HMAS-L).

REMARKS: The new subspecies is identical to *G. asteriscus* subsp. *asteriscus* and subsp. *nigrescens* in habit and chemistry but differs in its wider paraphyses, thinner ascospores, and smaller asci.

We recognize three *G. asteriscus* subspecies: subsp. *asteriscus* from Europe, subsp. *gracilispora* from China, and subsp. *nigrescens* from Peru:

Gyalidea asteriscus subsp. *nigrescens* (G. Thor) Jun. Yang & J.C. Wei, **comb. nov.**

MYCOBANK MB 514070

BASIONYM. *Solorinella nigrescens* G.Thor, Nord. J.Bot. 4(6): 823 (1985, “1984”).

= *Solorinella asteriscus* subsp. *nigrescens* (G.Thor) Vězda, Lumbsch & Øvstedal, Nova Hedwigia 50(3–4): 528 (1990).

Acknowledgments

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Literature cited

- Aptroot A, Lücking R. 2002. Proposal to conserve *Gyalidea* (lichenized fungi: *Asterothyriaceae*, *Ostropales*) against an additional name, *Solorinella*. *Taxon* 51 (3): 565.
- Aptroot A, Lücking R. 2003. Phenotype-based phylogenetic analysis does not support generic separation of *Gyalidea* and *Solorinella* (*Ostropales*: *Asterothyriaceae*). *Bibliotheca Lichenologica* 86: 53–78.

- Culberson CF. 1972. Improved conditions and a new data for the identification of lichen products by a standardized thin-layer chromatographic method. *J. Chromatography* 72: 113–125.
- Culberson CF, Johnson A. 1982. Substitution of methyl tert.-butyl ether for diethyl ether in the standardized thin-layer chromatographic method for lichen products. *J. Chromatography* 238: 483–487.
- Culberson CF, Kritinssen H. 1970. A standardized method for the identification of lichen products. *J. Chromatography* 46: 85–91.
- Thor G. 1985 (“1984”). A new species of *Solorinella* (*Asterothyriaceae*) from Peru. *Nord. J. Bot.* 4(6): 823–826.
- White FJ, James PW. 1985. A new guide to microchemical techniques for the identification of lichen substances. *Bul. British Lichen Soc.* 57(suppl.): 1–47.

New species and new records of *Diorygma* (Graphidaceae) from India: species with convergent exciples

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Abstract — Nine species of the lichen genus *Diorygma* with convergent exciples are recognized from India, of which six species are new to science viz. *D. albocinerascens*, *D. albovirescens*, *D. excipuloconvergentum*, *D. megaspermum*, *D. megistosporum*, and *D. panchganiense*. Two other species, *Diorygma* “*microsporum*”, and *D. “patwardhanii*”, clearly distinguished from the other species, are recorded, but are not formally described as new to science as the material is scanty. Additional specimens of *D. megasporum* are reported from India.

Key words — ascomycetes, taxonomy, *Ostropales*

Introduction

The lichen genus *Diorygma* is characterized by an inconspicuous pseudocortex, which results in a matte, often granular, farinose upper surface; lirellate ascocarps with a heavily pruinose disc; branched, anastomosing paraphyses with a thick gelatinous wall (usually only the lumina are distinctly visible); paraphysis tips that are reticulately interwoven to form an epithecium; asci of the *Graphis*-type; ascospores hyaline, very rarely brownish, transversely septate with lenticular spore locules or muriform, and the presence of norstictic, stictic and/or protocetraric acid chemosyndromes (Kalb et al. 2004).

Diorygma Eschw., a widely distributed, tropical to subtropical lichen genus with twenty-four species at the world level, was reintroduced by Staiger (2002) and monographed by Kalb et al. (2004). Subsequently, three species from Australia (Archer 2006, Archer & Elix 2008), one species from the Solomon Islands (Archer 2007), one species from Brazil (Cáceres 2007), and four species from India (Sharma & Makhija 2009) have been described in this genus.

The genus *Diorygma* in India was known from five species (Kalb et al. 2004)—*D. hieroglyphicum* (Pers.) Staiger & Kalb, *D. junghuhnii* (Mont. & Bosch) Kalb et al., *D. megasporum*, *D. pruinsum* (Eschw.) Kalb et al. and *D. tuberculosum* (Stirt.) Kalb et al.

In our previous studies on *Diorygma* from India four new species of the genus *Diorygma* with norstictic and salazinic acid as major compounds, namely *D. dealbatum* B.O. Sharma & Makhija, *D. inaequale* B.O. Sharma & Makhija, *D. manipurens* B.O. Sharma & Makhija and *D. verrucirimosum* B.O. Sharma & Makhija were described (Sharma & Makhija 2009).

In the present studies, nine species have been discovered with convergent lateral margins, very thick epihymenia and hyaline, muriform ascospores (Figs.1–3), all of which come close to the species *Diorygma megasporum* (which is also based on Indian material). In their monograph on the lichen genus *Diorygma*, Kalb et al. (2004), in describing their new species *D. megasporum*, clearly stated that, “the ascocarp morphology differs from other species of the genus by their slightly convergent lateral margins and a very thick epihymenium. It is possible that this species would be better accommodated in another, as yet undescribed genus, but molecular data should be sought to clarify this possibility.”

The nine species described below have been placed in the genus *Diorygma* but they may prove to be species of the new undescribed genus referred to above.

Materials & methods

Sections of ascocarps were mounted in water, 10% KOH (K), and lactophenol. The hymenium was stained with Lugol’s solution without and with pretreatment of KOH (I and KI). All measurements were made on material mounted in water. Chemical data was obtained by the standard method of TLC (Culberson & Kristinsson 1970, White & James 1985) using solvent systems benzene-dioxane-acetic acid (180:45:5), hexane-ethyl ether-formic acid (130:80:20) and toluene-ethyl acetate-formic acid (139:83:8). The specimens have been deposited in the Ajrekar Mycological Herbarium (AMH).

Taxonomy

Key to species with convergent exciples from India

- 1a. Asci 1–2-spored.....2
- 1b. Asci more than 2-spored5
- 2a. Ascospores exceeding 200 µm in length (ascocarps 0.5–9 mm long and 0.1–0.25 mm broad; ascospores 231–244 × 59–76 µm; consalazinic, constictic, cryptostictic and stictic acids present) *D. megaspermum*
- 2b. Ascospores not exceeding 200 µm in length.....3
- 3a. Ascospores exceeding 100 µm in length (ascocarps 0.5–6 mm long and 0.2–1 mm broad; ascospores 135–150 × 18–27 µm; cryptostictic, methylstictic, norstictic, and salazinic acids present) *D. albocinerascens*
- 3b. Ascospores not exceeding 100 µm in length.....4

- 4a. Ascocarps 1–2 mm long and 0.5–1.3 mm broad; ascospores 1–2/ascus, 75–99 × 24–30 µm; norstictic, salazinic and methylstictic acids present *D. panchganiense*
- 4b. Ascocarps 1–1.5 mm long and 0.2–0.5 mm broad; ascospores 1/ascus, 57–96 × 24–36 µm; consalazinic, constictic, cryptostictic, hypostictic, norstictic, and stictic acids present. *D. “patwardhanii”*
- 5a. Ascospores exceeding 200 µm in length; norstictic acid present 6
- 5b. Ascospores not exceeding 200 µm in length; norstictic acid absent 7
- 6a. Ascocarps whitish to pale, 1–4 mm long and 0.1–0.3 mm broad; ascospores 1–4 /ascus, 151–294 × 38–63(–84) µm; cryptostictic, norstictic and stictic acids present. *D. megistosporum*
- 6b. Ascocarps 1–6 mm long and 0.1–0.25 mm broad; ascospores 1–2–4/ascus, 147–273 × 34–67 µm; constictic, cryptostictic, methylstictic, norstictic, and salazinic acids present *D. excipuloconvergentum*
- 7a. Ascospores exceeding 100 µm in length (ascospores 1–8/ascus, 85–197 × 29–71 µm; constictic, stictic, and cryptostictic acids present) ... *D. megasporum*
- 7b. Ascospores not exceeding 100 µm in length. 8
- 8a. Ascocarps 3–7 mm long and 0.1–0.25 mm broad; ascospores 8/ascus, 46–63 × 17–25 µm; stictic acid present *D. “microsporum”*
- 8b. Ascocarps 0.5–3 mm long and 0.2–0.5 mm broad; ascospores 4–8/ascus, 66–99 × 12–36 µm; constictic, cryptostictic and stictic acids present *D. albovirescens*

New Species

Diorygma albocinerascens Makhija, Chitale & B.O. Sharma, sp. nov. FIGURE 4

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Similis *Diorygma megasporum*, *sed acida cryptosticticum, methylsticticum, norsticticum et salazinicum continens differt.*

ETYMOLOGY: From the Latin *albo*, white and *cinereus*, grey white; a reference to the colour of the thallus.

Holotypus—India, Maharashtra, Sindhudurg District, on the way to Phonda, 12.10.2000, U.V. Makhija & B.C. Behera, 00.263: AMH.

THALLUS crustose, corticolous, whitish gray, epiphloeodal, continuous, smooth to rough, finely cracked, pseudocortex not visible, hypothallus black. **ASCOCARPS** lirelline, 0.5–6 mm long and 0.2–1 mm broad, simple, furcate, dendroidly branched, immersed, straight or curved, concolorous with the thallus, with obtuse ends; thalline margin slightly raised, concolorous or paler than the thallus, entire, studded with crystals, encircling exciple; disc narrow, slit-like, light brown, slightly pruinose; exciple convergent, poorly developed, 2–3-striate, present at the base, thin, pale brown, blackish brown at apices, covered by a thick, thalline margin up to the top; epihymenium dark blackish brown

to almost black, 15–21 μm thick, covered by fine pruina; hymenium hyaline, not inspersed, 126–215 μm tall, KI+ blue; paraphyses branched, interwoven, thickened, compact at apices; asci 1–2-spored. ASCOSPORES hyaline, muriform, ellipsoid, peripheral and central spore locules of equal size, 135–150 \times 18–27 μm , I+ violet.

CHEMISTRY—Cryptostictic, methylstictic, norstictic, and salazinic acids (major).

ADDITIONAL SPECIMENS EXAMINED—Maharashtra, Kolhapur District, Panhala, P.G. Patwardhan & C.R. Kulkarni, 74.1079; G.S. Chitale, 02.283. Pune District, Amby valley, 26 km ahead of Lonavala, B.A. Adawadkar & B.C. Behera, 03.206, 03.207; B.A. Adawadkar & G.S. Chitale, 03.191; B.A. Adawadkar & N. Verma, 03.246; G.S. Chitale & B.A. Adawadkar, 03.253, 03.259; U.V. Makhija, 06.105; Purandar fort, P.D. Badhe, 71.38; Durgwadi, U.V. Makhija, 04.146; Durgawadi, Junnar, U.V. Makhija & A.V. Dube, 03.296; Deoghar, Lonavala, U.V. Makhija, 06.139, 06.142, 06.143; Khandala, B.A. Adawadkar & G.S. Chitale, 03.199. Ratnagiri District, Chiplun, G.S. Chitale, 04.78; G.S. Chitale, 07.12, 07.13. Satara District, Table Land, Panchgani, N. Verma, 06.221, 06.222, 06.224; Wilson Point, Mahabaleshwar, P.G. Patwardhan & M.B. Nagarkar, 85.2938; Near Arther Seat Point, M.B. Nagarkar & A. V. Prabhu, 74.1724; Ambenali ghat, Mahabaleshwar, G.S. Chitale, 06.195. Sindhudurg District, Amboli, C.R. Kulkarni & A.V. Prabhu, 74.1444. Thane District, Malshej Ghat, Neemgiri, B.C. Behera & U.V. Makhija, 02.34. On the way to Phonda from Radhanagari, U.V. Makhija & K.R. Randive, 00.281: AMH

REMARKS—With convergent lateral margins and a very thick epihymenium, *Diorygma albocinerascens* closely resembles *Diorygma megasporum*. The spore dimensions in each species are similar: *D. megasporum* 80–170(–220) \times 21–55 μm compared to *D. albocinerascens* 135–150 \times (12–)18–27 μm . However the two species differ in their chemistry: *D. megasporum* has constictic, stictic, and α -acetylconstictic acids according to Kalb et al. (2004) while the new species has cryptostictic, methylstictic, norstictic, and salazinic acids. It differs in lacking the stictic acid present in *D. megasporum*.

Diorygma albovirescens Makhija, Chitale & B.O. Sharma, sp. nov.

FIGURE 5

MYCOBANK MB 513537

Similis *Diorygma intermedium*, *sed acida constictum, cryptosticticum et sticticum continens et excipulum convergentum differt.*

ETYMOLOGY: From the Latin *albo*, white and *virescens*, greenish a reference to colour of the thallus.

Holotypus—India, Maharashtra, Ratnagiri District, Chiplun, 15.5.2004, G.S. Chitale, 04.80: AMH.

THALLUS crustose, corticolous, greenish white, epiphloeodal, continuous, smooth to cracked, pseudocortex indistinct, hypothallus indistinct. ASCOCARPS lirelline, 0.5–3 mm long and 0.2–0.5 mm broad, simple to branched, flexuous, immersed to semi-emergent, concolorous with the thallus, fissure like; thalline margin raised and often separated from the thallus or the disc by a

deep slit, concolorous or paler than the thallus, entire, studded with crystals, encircling exciple; disc narrow, slit-like, blackish brown, covered with white pruina; exciple poorly developed, 2–3-striate, present at base, thin, pale brown to blackish-brown at apices, convergent, covered by a thick, thalline margin up to the top; epihymenium dark, blackish brown to almost black, 34–42 μm thick; hymenium hyaline, not inspersed, 126–250 μm tall, KI+ blue; paraphyses branched, thickened, interwoven, compact at apices; asci 4–8-spored. ASCOSPORES hyaline, muriform, ellipsoid, peripheral and central spore locules of equal size, 66–99 \times 12–36 μm , I+ violet.

CHEMISTRY—Constictic, cryptostictic, and stictic acids (major).

ADDITIONAL SPECIMENS EXAMINED—Maharashtra, Ratnagiri District, Chiplun, G.S. Chitale, 04.77, 04.81, 04.84, 04.85, 04.88, 04.90. Satara District, Mahabaleshwar, Lingmala, B.A. Adawadkar, 04.14. Sindhudurg District, on the way to Vaibhavwadi, B.A. Adawadkar & K.R. Randive, 00.373: AMH

REMARKS—*Diorygma albovirescens* resembles *D. intermedium* Kalb et al.: both have long \pm flexuous, branched ascocarps, appearing as fissures, immersed in the thallus, a whitish disc surrounded by a thalline margin often distinctly raised and separated from the thallus by a deep slit. However, the chemistry of the species differ: *D. intermedium* has hypostictic acid and derivatives (hypostictic, hypoconstictic, and α -acetylhypoconstictic acids) whereas *D. albovirescens* has stictic acid derivatives (constictic, cryptostictic, and stictic acids). The two species also differ in distribution. *Diorygma intermedium* has a neotropical distribution in contrast to *D. albovirescens* which is so far known only from India.

***Diorygma excipuloconvergentum* Makhija, Chitale & B.O. Sharma, sp. nov.**

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FIGURE 1–3, 6

Similis *Diorygma megasporum*, sed *ascosporis majoribus et acida consticticum, cryptosticticum, methylsticticum, norsticticum et salazinicum continens differt.*

ETYMOLOGY: From the Latin *excipulo*, exciple and *convergens*, convergent, a reference to convergent exciple.

Holotypus—India, Maharashtra, Pune District, Purandar Fort, 13.9.2002, U.V. Makhija & A.V. Bhosale, 02.60: AMH.

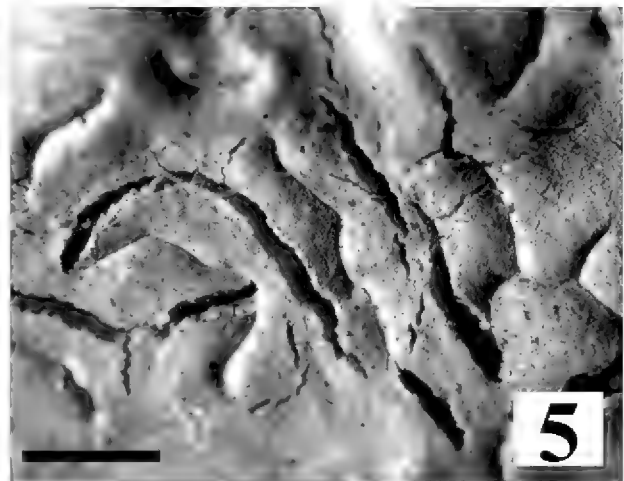
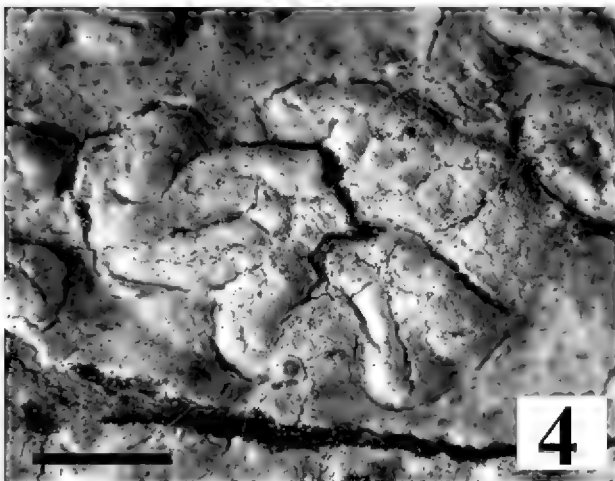
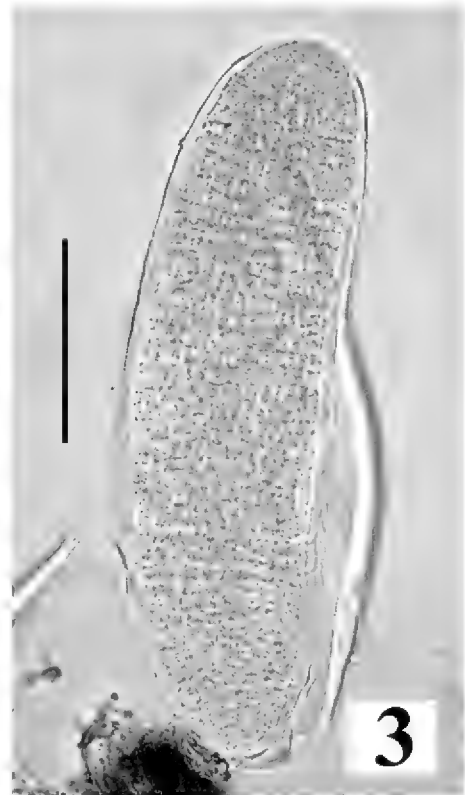
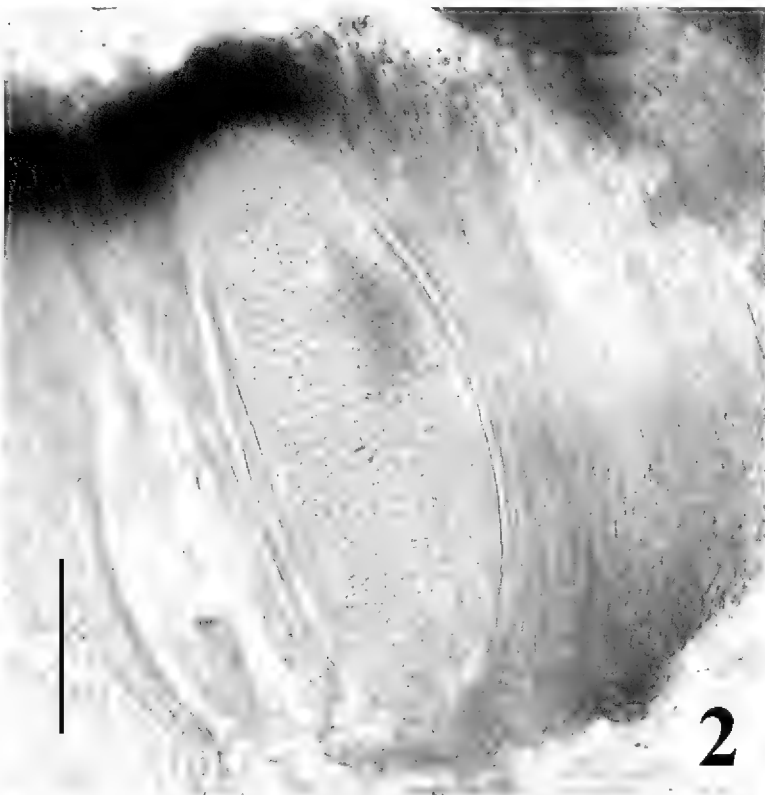
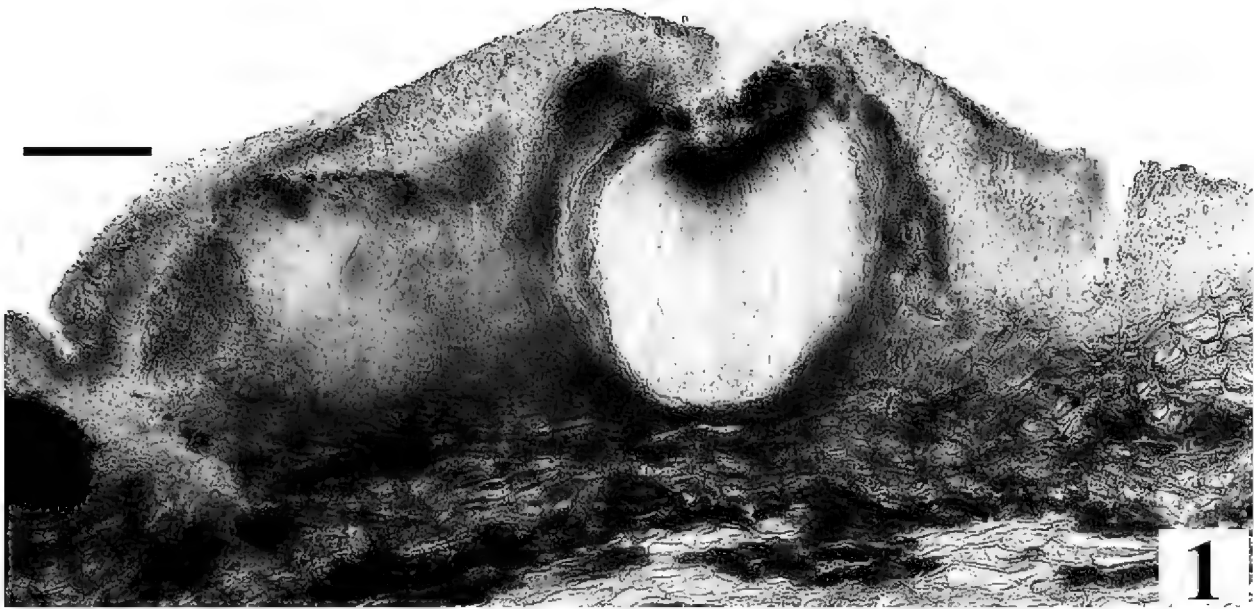
THALLUS crustose, corticolous, epiphloeodal, continuous, smooth to cracked, sometimes uneven, pale glaucous green to olivaceous buff or whitish, pseudocortex indistinct, hypothallus black. ASCOCARPS lirelline, 1–6 mm long and 0.1–0.25 mm broad, simple to rarely branched, immersed to semi-emergent, concolorous with the thallus, with obtuse ends; thalline margin raised, overarching the exciple, studded with crystals; disc white, narrow, slit-like, later moderately open, white pruinose; exciple poorly developed, pale yellow, indistinctly 2–4-striate, blackish brown at apices, present at the base,

converging at the apical portion; epihymenium hyaline to blackish brown, 21–50 µm thick; hymenium hyaline, not inspersed, 105–185 µm tall, lateral and upper part KI+ blue; paraphyses branched, long, thin, septate, branched at apices; asci 1–2(–4)-spored. ASCOSPORES hyaline, muriform, ellipsoid, oblong, peripheral and central spore locules of equal size, 147–273 × 34–67 µm wide, I+ violet.

CHEMISTRY—Constictic, cryptostictic, methylstictic, norstictic, and salazinic acids (major).

ADDITIONAL SPECIMENS EXAMINED—**Maharashtra, Ahmednagar District**, Bhandardara, G.S. Chitale & B.A. Adawadkar, 02.161. **Kolhapur District**, Amba, C.R. Kulkarni & A.V. Prabhu, 74.1249, 74.1250, 74.1259, 74.1262, 74.1269, 74.1329, 74.1369; Panhala, P.G. Patwardhan & A.V. Prabhu, 74.1055, 74.1056, 74.1057, 74.1059, 74.1062, 74.1064, 74.1065, 74.1066, 74.1067, 74.1068, 74.1073, 74.1074, 74.1082, 74.1084, 74.1086, 74.1092, 74.1096, 74.1098, 74.1099, 74.1100, 74.1104, 74.1107, 74.1110, 74.1111, 74.1115, 74.1116, 74.1123, 74.1124, 74.1126, 74.1127, 74.1131, 74.1185, 74.1443; U.V. Makhija & B.C. Behera, 00.277, 00.282; B.A. Adawadkar & K.R. Randive, 00.327; B.C. Behera & V.A. Mantri, 00.328; U.V. Makhija & K.R. Randive, 00.385, 00.386, 00.387, 00.394; U.V. Makhija & G.S. Chitale, 04.442; B.C. Behera & N. Verma, 04.438; Radhanagari guest house, B.A. Adawadkar & K.R. Ranadive, 00.377. **Nasik District**, Saptashringi Gad, B.C. Behera & G.S. Chitale, 02.183, 02.184a, 02.193, 02.233. **Pune District**, Bhimashankar, U.V. Makhija, 97.1, 97.2, 97.3, 97.16; Khandala, Boma Hills, P.G. Patwardhan & M.B. Nagarkar, 74.86, 74.630, 74.631, 74.633, 74.635, 74.637, 74.638, 74.639, 74.640, 74.641, 74.644, 74.645, 74.646, 74.647, 74.650, 74.651; B.A. Adawadkar & K.R. Randive, 00.89, 00.113; Purandar Fort, B.A. Adawadkar & P.G. Patwardhan, 93.14, 93.15, 93.24; U.V. Makhija & A.V. Bhosale, 02.53, 02.58, 02.59, 02.61, 02.62; Sinhagad Fort, U.V. Makhija & B.A. Adawadkar, 00.49, 00.50; Lonavala, Walwan dam, B.C. Behera & B.A. Adawadkar, 02.124, 02.125, 02.126, 02.128, 02.129; Lonawala, G.S. Chitale, 04.250; Malshej Ghat, Neemgiri, U.V. Makhija & A.V. Bhosale, 02.26, 02.27; Durgawadi, U.V. Makhija & N. Verma, 03.319; G.S. Chitale, 04.138; B.C. Behera, 04.139, 04.140, 04.141, 04.142, 04.143, 04.144; U.V. Makhija, 04.145, 04.147; G.S. Chitale, 04.157; Mulshi Dam, P. Rao & G.S. Chitale, 03.442, 03.447; Tamhini Ghat, P. Rao & G.S. Chitale, 03.443. **Raigad District**, Karnala, G.S. Chitale & A.V. Bhosale, 02.90; Warandha Bhor-Mahad, C.R. Kulkarni, 74.1946; M.B. Nagarkar & A.V. Prabhu, 74.1947, 74.1971; Hirdoshi, Bhor-Mahad, M.B. Nagarkar, 74.1976, 74.1977, 74.1978. **Ratnagari District**, Chiplun, C.R. Kulkarni, 02.271, G.S. Chitale, 04.76, 04.82, 04.83, 04.86; Kasheli Ghat, Poladpur, C.R. Kulkarni, 74.1935. **Satara District**, Ajinkyatara, U.V. Makhija, 04.104; Mahabaleshwar, B.A. Adawadkar, 97.58; Panchgani, G.S. Chitale, 01.39; B.A. Adawadkar, 01.45, A.V. Bhosale, 01.54; Lingmala, G.S. Chitale, 04.4, 04.5, 04.150; Panchgani, 04.6. **Sindhudurg District**, Amboli, C.R. Kulkarni, 74.1390; C.R. Kulkarni, 74.2296, 74.2329; Amboli, P.G. Patwardhan & C.R. Kulkarni; U.V. Makhija & B.A. Adawadkar, 00.147, 00.148, 00.149, 00.172; U.V. Makhija & G.S. Chitale, 04.395; Mahadevgad, N. Verma, 04.380; Ajra, B.C. Behera & N. Verma, 04.332, 04.410: AMH

FIGURES 1–5 1. Vertical section of ascocarp *D. excipuloconvergentum* (Bar = 100 µm), 2–3. *D. excipuloconvergentum* ascospores Bar = 50 µm, Habit. 4. *D. albocinerascens*. (Holotype) 5. *D. albovirescens* (Holotype). Bar = 1 mm



REMARKS—*Diorygma excipuloconvergentum* closely resembles *D. megasporum* but differs in producing norstictic, salazinic, cryptostictic and methylstictic acids in contrast to *D. megasporum* which has constictic, cryptostictic, and stictic acids. Indian specimens of *D. megasporum* has slightly smaller ascospores of $85\text{--}197 \times 29\text{--}71 \mu\text{m}$ compared to $147\text{--}273 \times 34\text{--}67 \mu\text{m}$ in *D. excipuloconvergentum*.

Diorygma excipuloconvergentum resembles the new species *D. megistosporum* (described here in that both species have 1–4 spored asci and large ascospores but *D. megistosporum* differs in producing only cryptostictic, norstictic, and stictic acids.

D. excipuloconvergentum is one of the most predominant species of lichens in Maharashtra and has been collected from dry deciduous and semi-evergreen forests.

***Diorygma megaspermum* Makhija, Chitale & B.O. Sharma, sp. nov.**

FIGURE 7

MYCOBANK MB 513539

Similis *Diorygma megasporum*, sed *ascosporis majoribus et acida consalazinicum, consticticum, cryptosticticum et sticticum continens differt.*

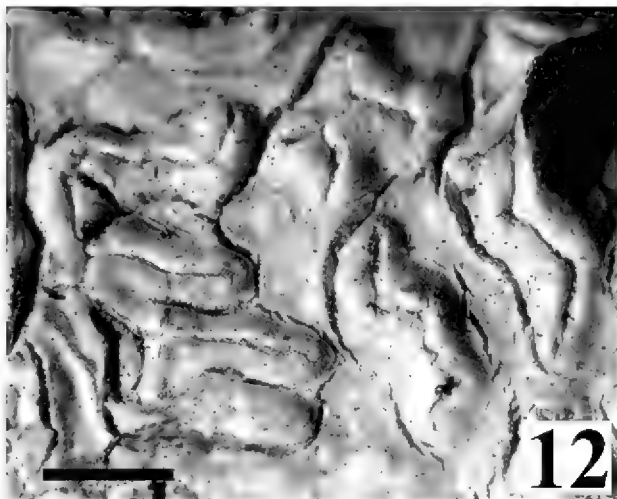
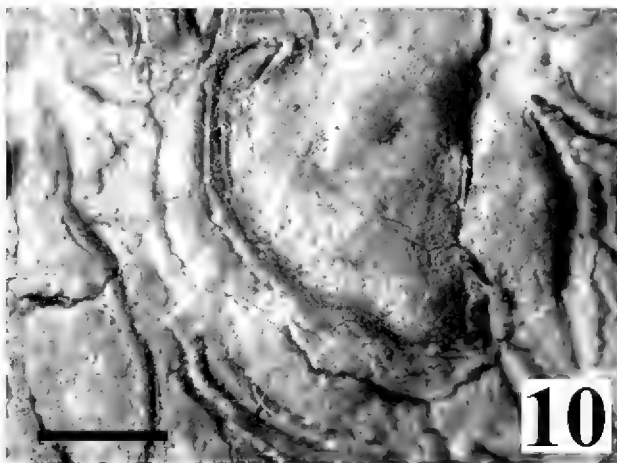
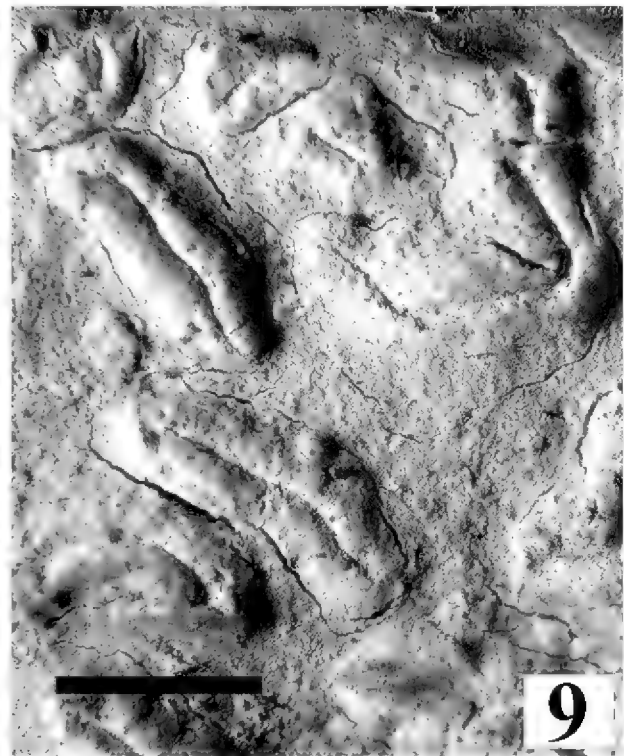
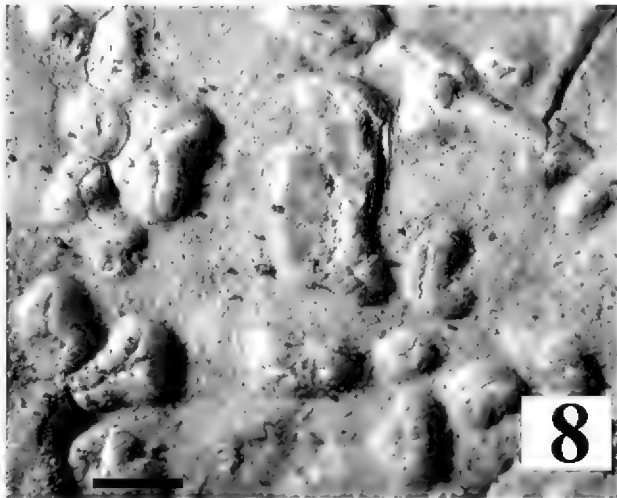
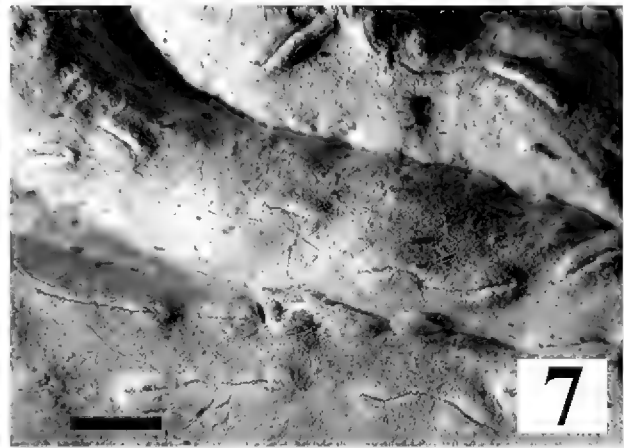
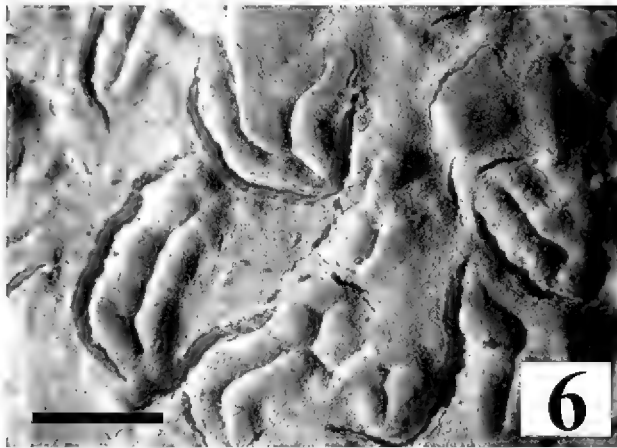
ETYMOLOGY: From the Latin *mega*, large and *spermus*, seed; a reference to large ascospores.

Holotypus—India, Maharashtra, Sindhudurg District, Ajra to Amboli Road, 7.12.1974, P.G. Patwardhan & A.V. Prabhu, 74.2255: AMH.

THALLUS crustose, corticolous, epiphloeodal, continuous, smooth, greenish white; pseudocortex invisible; black hypothallus present. ASCOCARPS lirelline, 0.5–9 mm long and 0.1–0.25 mm broad, simple, appearing like a dotted line, to rarely branched, immersed to slightly emergent, flexuous, scattered, concolorous with the thallus, tapering acute apices; thalline margin paler than the thallus or white, raised, often quite rugose, entire, studded with crystals, encircling exciple; disc narrow, pruinose; exciple poorly developed, convergent, 2–6-striate, blackish brown at apices and dark brown laterally, present at base, covered by a thick thalline margin up to the top; epihymenium dark blackish brown, 29–42 μm thick; hymenium hyaline, not inspersed, 113–155 μm tall, lateral and upper part KI+ blue; paraphyses branched, long, thin, septate, thickened, branched and interwoven at apices; asci 1-spored. ASCOSPORES hyaline, muriform, without gelatinous sheath, ovoid, oblong, peripheral and central spore locules of equal size, $231\text{--}244 \times 59\text{--}76 \mu\text{m}$, I+ violet.

CHEMISTRY—Consalazinic, constictic, cryptostictic, and stictic acids (major).

FIGURES 6–12 Habit. 6. *D. excipuloconvergentum*. (Holotype) 7. *D. megaspermum* (Holotype). 8. *D. megasporum*. 9. *D. megistosporum*. (Holotype) 10. *D. "microsporum"*. 11. *D. panchganiense*. (Holotype) 12. *D. "patwardhanii"*. Bar = 1 mm



ADDITIONAL SPECIMEN EXAMINED—Maharashtra, Satara District, Lingmala, Mahabaleshwar, B.A. Adawadkar, 04.8: AMH

REMARKS— The new species *Diorygma megaspermum* is comparable to the new species *D. excipuloconvergentum* as both have large ascospores but *D. megaspermum* can be distinguished from the latter species on the basis of the chemistry. *D. megaspermum* has consalazinic, constictic, cryptostictic, and stictic acids while *D. excipuloconvergentum* has constictic, cryptostictic, methylstictic, norstictic, and salazinic acids in its thallus.

Diorygma megaspermum is some what similar to *D. megasporum*, however, differs in having large ascospores and lichen substances.

This species has been collected in semi-evergreen forests near a waterfall, where a few elements of primary forests are still present.

Diorygma megistosporum Makhija, Chitale & B.O. Sharma, sp. nov. FIGURE 9

MYCOBANK MB 513540

Similis *Diorygma megasporum*, sed ascosporis majoribus et acida cryptosticticum, norsticticum et sticticum continens differt.

ETYMOLOGY: From the Latin *megisto* very large, and *sporum*, ascospores; a reference to very large ascospores.

Holotypus—India, Maharashtra, Pune District, Bhimashankar, 10.10.1970, P.G. Patwardhan & P.D. Badhe, 70.59: AMH.

THALLUS crustose, corticolous, epiphloeodal, continuous, smooth to cracked, glaucous, whitish to greenish gray, thin, epruinose, pseudocortex invisible, hypothallus black. ASCOCARPS lirelline, 1–4 mm long and 0.1–0.3 mm broad, simple to rarely branched, flush with the thallus, rarely somewhat raised, paler than the thallus, whitish, or concolorous with the thallus, with acute or more or less rounded apices; thalline margin mealy entire, studded with crystals, encircling exciple; disc narrow, concealed, slit like or broader, blackish brown to black, white pruinose when open; exciple poorly developed, 3–4 indistinct striation, blackish brown at apices, present at the base, pale yellow to almost hyaline, apically convergent, covered by a thick thalline margin up to the top; epihymenium blackish brown, distinctly developed, 21–29 µm thick. hymenium hyaline, not inspersed, 143–201 µm tall, lateral and upper part KI+ blue; paraphyses profusely branched, long, thin, septate, thickened, interwoven at apices; asci 1–4-spored. ASCOSPORES hyaline, muriform, fusiform-oblong, without gelatinous sheath, peripheral and central spore locules of equal size, 151–294 × 38–63(–84) µm, I+ violet.

CHEMISTRY—Cryptostictic, norstictic, and stictic acids present.

ADDITIONAL SPECIMENS EXAMINED—Maharashtra, Kolhapur District, Panhala, P.G. Patwardhan & C.R. Kulkarni, 74.1103. Pune District, Bhimashankar, P.G. Patwardhan & P.D. Badhe, 70.26, 70.54; P.G. Patwardhan & P.D. Badhe, 70.62; Khandala, C.R. Kulkarni, 73.205. Satara District, Mahabaleshwar, Lodwick Point, P.D. Badhe, 72.21; A.V. Prabhu

& M.B. Nagarkar, 74.1841, 74.1847; Dhobi fall, M.B. Nagarkar, 73.2927; Pratapgad, C.R. Kulkarni, 73.2945, 73.2949; Lingmala Water Fall, V.D. Vartak, L 129: AMH

REMARKS—*Diorygma megistosporum* stands distinct among all the known species of *Diorygma* by virtue of its very large ascospores of $151\text{--}294 \times 38\text{--}63(-84) \mu\text{m}$.

Diorygma megistosporum is somewhat similar to *D. megasporum*, in ascocarp morphology as both have poorly developed convergent exciples with lateral brownish striations and thick blackish-brown epihymenium but the latter species has much smaller ascospores of $85\text{--}197 \times 29\text{--}71 \mu\text{m}$ and has constictic, cryptostictic, and stictic acids in specimens at hand.

Diorygma panchganiense Makhija, Chitale & B.O. Sharma, sp. nov. FIGURE 11

MYCOBANK MB 513541

Similis *Diorygma inaequale*, sed *excipulum convergentum differt*.

ETYMOLOGY: From the Latin *ensis*, place of origin; and place Panchgani, the type locality.

Holotypus—India, Maharashtra, Satara District, Panchgani, Tata Holiday Home, 29.9.2003, U.V. Makhija & B.C. Behera, 03.371: AMH.

THALLUS crustose, corticolous, grayish, epiphloeodal, continuous, smooth to rough, finely cracked, pseudocortex invisible, hypothallus distinctly black. ASCOCARPS lirelline, 1–2 mm long and 0.5–1.3 mm broad, simple, semi-emergent, straight or curved, concolorous with the thallus; thalline margin raised, concolorous or paler than the thallus, entire, studded with crystals, encircling exciple; disc narrow, when open pruinose; exciple poorly developed, 2–3 striate, present at the base, thin, pale brown laterally, blackish brown at apices, convergent; epihymenium dark blackish brown to almost black, $15\text{--}20 \mu\text{m}$ thick, covered by fine pruina; hymenium hyaline, not interspersed, $126\text{--}200 \mu\text{m}$ tall, KI+ blue; paraphyses branched, long, thin, thickened, reticulately interwoven, compact at apices, forming the epihymenium; asci 1–2-spored. ASCOSPORES hyaline, muriform, ellipsoid, peripheral and central spore locules of equal size, $75\text{--}99 \times 24\text{--}30 \mu\text{m}$, I+ violet.

CHEMISTRY—Norstictic, salazinic, and methylstictic acids present.

ADDITIONAL SPECIMENS EXAMINED—Maharashtra, Satara District, Panchgani, Tata Holiday Home, U.V. Makhija & B.C. Behera, 03.367, 03.368, 03.370, 03.372, 03.507: AMH

REMARKS—*Diorygma panchganiense* differs from the closely related *D. albocinerascens* by the larger ascospores ($135\text{--}150 \times 12\text{--}27 \mu\text{m}$) in *D. albocinerascens*.

D. inaequale, having norstictic and salazinic acids and more or less similar ascospore range, can easily be differentiated from the present new species especially by the divergent exciple in that species.

Other species

Diorygma megasporum Kalb, Staiger & Elix, Symb. Bot. Upsal. 34(1): 160 (2004).

FIGURE 8

REMARKS—This species was described and recorded from the states of Maharashtra, and Sikkim in India by Kalb et al. (2004) who cited three specimens; the species is however, more widely distributed as shown by the specimens listed below. These specimens differ slightly in chemistry from *D. megasporum* and contain constictic, cryptostictic, and stictic acids as major compounds whereas Kalb et al. (2004) reported the presence of constictic, stictic, and α -acetylconstictic acids as major compounds. In the specimens below, the ascospores are $85\text{--}197 \times 29\text{--}71 \mu\text{m}$ compared to $80\text{--}170\text{--}220 \times 21\text{--}55 \mu\text{m}$ reported by Kalb et al. (2004) We do not think that these differences are significant and therefore they are placed in *D. megasporum*.

A detailed description of *D. megasporum* is given by Kalb et al. (2004).

ADDITIONAL SPECIMENS EXAMINED—Maharashtra, Kolhapur District, Amba, C.R. Kulkarni & A.V. Prabhu, 74.1245, 74.1246, 74.1247, 74.1247b, 74.1248, 74.1252, 74.1253, 74.1257, 74.1260, 74.1264, 74.1265, 74.1266, 74.1268, 74.1270, 74.1271, 74.1273, 74.1274, 74.1275, 74.1276, 74.1277, 74.1280, 74.1281, 74.1328, 74.1330, 74.1332, 74.1334, 74.1338, 74.1339a, 74.1345; Panhala, P.G. Patwardhan & C.R. Kulkarni, 74.1058, 74.1072, 74.1118; P.G. Patwardhan & A.V. Prabhu, 74.1108; U.V. Makhija & K.R. Randive, 00.382, 00.383, 00.388, 00.393, 00.482, 00.484; Vishalgad-Amba-Gajapur Road, A.V. Prabhu & M.B. Nagarkar, 74.2162, 74.2188, 74.2200. Pune District, Khandala, Boma hills, C.R. Kulkarni & M.B. Nagarkar, 74.636, 74.643, 74.648. Raigad District, Karnala, M.B. Nagarkar & A.V. Prabhu, 74.568, 74.589, 74.601; Warandha, Bhor to Mahad, M.B. Nagarkar & A.V. Prabhu, 74.1939, 74.1940, 74.1954, 74.1964. Ratnagiri District, Nerur, P.G. Patwardhan, 75.441; Dabhole Ghat, M.B. Nagarkar & A.V. Prabhu, 74.2039, 74.2040a; Nivali village-Chiplun, P.G. Patwardhan, M.B. Nagarkar & C.R. Kulkarni, 74.2065, 74.2104, 74.2120, 74.2126, 74.2127, 74.2128, 74.2131, 74.2134, 74.2135, 74.2137, 74.2138, 74.2140, 74.2143, 74.2146; G.S. Chitale, 02.272, 02.273a; Ganpatipule, C.R. Kulkarni, 74.2046, 74.2080; Modke Agar, G.S. Chitale, 07.15. Satara District, Panchgani, A.V. Bhosale, 01.53. Sindhudurg District, Amboli, C.R. Kulkarni & A.V. Prabhu, 74.1395, 74.1400, 74.1426, 74.1652, 74.1653, 74.2243, 74.2247; U.V. Makhija & B.A. Adawadkar, 00.166, 00.171, 00.173; Radhanagari-Phonda, U.V. Makhija & K.R. Randive, 00.273; Vaibhavwadi, B.A. Adawadkar & K.R. Randive, 00.371, 00.374: AMH

Diorygma "microsporum" ad int.

FIGURE 10

THALLUS crustose, corticolous, glaucous green, epiphloeodal, continuous, smooth to cracked, unevenly thickened, pseudocortex invisible, black hypothallus present. ASCOCARPS lirelline, 3–7 mm long and 0.1–0.25 mm broad, simple to branched, immersed to emergent, irregularly curved, wavy, concolorous with the thallus, tapering acute apices; thalline margin entire, concolorous with the thallus, studded with crystals, encircling exciple; disc narrow, reddish brown to blackish brown, when open pruinose; exciple poorly

developed, 2–5 striate, orange brown, present at base, carbonized at apices, convergent, covered by a thick thalline margin up to the top; epihymenium brownish black, made of interwoven apices of paraphyses tips; hymenium hyaline, not inspersed, 80–92 μm tall, lateral and upper part KI+ blue; paraphyses branched, long, thin, septate, thickened, branched at apices and interwoven; asci 8-spored. ASCOSPORES hyaline, muriform, without gelatinous sheath, ovate, oblong, lumina lenticular, peripheral and central spore locules of equal size, 46–63 \times 17–25 μm , I+ violet.

CHEMISTRY—Stictic acid (major).

SPECIMEN EXAMINED—Maharashtra, Satara District, Mahabaleshwar, Pratapgad, P. D. Badhe, 72.24: AMH

REMARKS—*Diorygma* “*microsporum*” is somewhat similar to *D. poiteau* (Fée) Kalb et al. as both species have a convergent, striate exciple, 8-spored asci and small ascospores. However, they differ in chemistry. *D. “microsporum”* produces only stictic acid while *D. poiteau* produces hypostictic and hypoconstictic acids as major compounds.

Since we have only a single, scanty specimen at hand it would be premature to describe the species as new. Therefore, it has not been formally described as a new species.

Diorygma “*patwardhanii*” ad int.

FIGURE 12

THALLUS crustose, corticolous, grayish white, epiphloeodal, continuous, smooth to rough, deeply cracked and appearing areolate, pseudocortex invisible, hypothallus black. ASCOCARPS concolorous with the thallus, lirelline, 1–1.5 mm long and 0.2–0.5 mm broad, simple to branched, grouped, immersed, flush with the thallus; thalline margin raised, concolorous or paler than the thallus, entire, studded with crystals, encircling exciple; disc concolorous with the thallus, narrow, pruinose; exciple hyaline, poorly developed, 2–3 striate, present at the base, thin, pale brown laterally, blackish brown at apices, convergent; epihymenium dark blackish brown, 10–20 μm thick; hymenium hyaline, 105–125 μm tall, KI+ blue; paraphyses branched, long, thin, thickened, interwoven, compact at apices; asci 1-spored. ASCOSPORES hyaline, muriform, ellipsoidal, peripheral and central spore locules of equal size, 57–96 \times 24–36 μm , I+ violet.

CHEMISTRY—Consalazinic, constictic, cryptostictic, and stictic acids (major) and hypostictic and norstictic acids (minor).

SPECIMENS EXAMINED—Maharashtra, Ratnagiri District, Chiplun, G.S. Chitale, 04.87. Satara District, Mahabaleshwar, Lingmala, B.A. Adawadkar, 04.13: AMH

REMARKS—*Diorygma* “*patwardhanii*” is distinguished by 1-spored asci and the presence of consalazinic, constictic, cryptostictic and stictic acids. The species

resembles *D. albovirescens*, having ascospores of similar size but *D. albovirescens* has 4–8-spored asci and has only constictic, cryptostictic, and stictic acids.

Although we have two specimens from two different localities, both of them are too scanty to be designated as a type specimen. Therefore they have not been formally recorded as a new species.

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Literature cited

- Archer AW. 2006. The lichen family *Graphidaceae* in Australia. *Biblioth. Lichenol.* 94: 1–191.
- Archer AW. 2007. Key and checklist for the lichen family *Graphidaceae* (lichenized *Ascomycota*) in the Solomon Islands. *Systematics & Biodiversity* 5(1): 9–22.
- Archer AW, Elix JA. 2008. Three new species in the Australian *Graphidaceae* (lichenized *Ascomycota*). *Australasian Lichenology* 63:26–29.
- Cáceres MES. 2007. Corticolous crustose and microfoliose lichens of northeastern Brazil. *Libri Botanici* 22: 1–168.
- Culberson CF, Kristinsson H. 1970. A standardized method for the identification of lichen products. *J. Chromatogr.* 46: 85–93.
- Kalb K, Staiger B, Elix JA. 2004. A monograph of the lichen genus *Diorygma* – a first attempt. *Symb. Bot. Ups.* 34: 133–181.
- Sharma BO, Makhija U. 2009. Four new species in the lichen genus *Diorygma*. *Mycotaxon* 107: 87–94.
- Staiger B. 2002. Die Flechtenfamilie *Graphidaceae*: Studien in Richtung einer natürlicheren Gliederung. *Biblioth. Lichenol.* 85: 1–526.
- White FJ, James PW. 1985. A new guide to microchemical techniques for the identification of lichen substances. *Bull. Br. Lichen Soc.* 57(Suppl.): 1–41.

Two new lichenicolous species of *Dacampia* on *Teloschistaceae*

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Abstract—Two new lichenicolous fungi in the genus *Dacampia* are described: *Dacampia caloplacicola* on the thallus of saxicolous *Caloplaca crenularia* from western Turkey and *D. xanthomendozae* on the thallus of epiphytic *Xanthomendoza* from Argentina. The new species differ from those previously recognized in the genus in size and septation of ascospores, as well as occurring on unrelated hosts. They are the first species of the genus recognized on the host lichen family *Teloschistaceae*.

Key words—*Ascomycota*, *Dacampiaceae*, biodiversity, lichens

Introduction

A key and synopsis to the seven known species of *Dacampia*, along with drawings of the ascospores was recently provided by Halıcı & Hawksworth (2008). With the description of two additional species — *Dacampia cladoniicola* Halıcı & A.O. Türk (Halıcı et al. 2008) and *D. rubra* Halıcı et al. (Halıcı et al. 2009) — the number of species in the genus increased to nine. Here, we describe two more *Dacampia* species: *D. caloplacicola*, occurring on *Caloplaca crenularia* (With.) J.R. Laundon from Turkey and *D. xanthomendozae* on *Xanthomendoza* from Argentina.

Material and methods

The type material of the new species is deposited in ANES and BCRU. Specimens were examined with an Olympus BH-2 research microscope fitted

with Nomarski differential interference contrast optics and a drawing tube. Photomicrographs were prepared on a Nikon Eclipse 80i and a Nikon Coolpix P2. Sections were prepared by hand and examined in I (Merck Lugol's iodine), with [KI] and without [I] pre-treatment with 10% KOH, 10% KOH alone, and water. Asci and ascospore measurements were made in water. Ascospore measurements were given as: (min.)(X-SD)-X-(X+SD)(max.), where min. and max. are the extreme values, X the arithmetic mean, and SD the corresponding standard deviation. The length/breadth (l/b) ratio of the ascospores is given in the same way.

The species

Dacampia caloplacicola Halici, Candan & Etayo, sp. nov.

FIGURE 1

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Dacampia species insignis ascosporis (3-)4-transseptatis et 1-2-longiseptatis, (17-)18.5-19.9-21.3(-23) × (6-)6.5-7.2-7.9(-8) µm, l/b = 2.5-2.8-3.0(-3.3).

TYPE COLLECTION: Turkey, Afyon, Sandıklı, North of Çevrepınar Village, 38°30'N, 29°59'E, alt. 1010 m, on the thallus of *Caloplaca crenularia* on siliceous rocks, 27 November 2007, leg. M. Candan (ANES 12291 – holotype).

ETYMOLOGY: The epithet "*caloplacicola*" refers to the host *Caloplaca*.

DESCRIPTION: Lichenicolous, on the thallus of *Caloplaca crenularia*, causing discoloration, and eventually destroying the thallus, pathogenic. VEGETATIVE HYPHAE not observed. ASCOMATA perithecioid, arising singly, immersed at first with only the ostiole and surrounding zone externally visible, semi-immersed at maturity, 300–500 µm diam, black, subglobose. EXCIPLE composed of 6–8 layers of angular pseudoparenchymatous cells (textura angularis), 20–50 µm thick, the individual cells somewhat radially compressed, reddish brown to brown, individual cells 10–16 × 6–8 µm in vertical section, smooth, walls ca 1 µm thick. HAMATHECIUM of cellular pseudoparaphyses, abundant, septate, branched and anastomosed, 1–2 µm wide, KI, I–. ASCI elongate-clavate, shortly stalked, bitunicate in structure, 8-spored when young, in general (4–)6-spored at maturity, I–, 71–85 × 13–16 µm ($n = 20$). ASCOSPORES irregularly biserially or uniserially arranged in the asci, ellipsoid, brown and smooth, muriform, with (3–)4 transsepta and 1–2 longisepta, generally constricted at the medium septa, sometimes with small lipid droplets in each cell, terminal cells concolorous with central cells, rounded to somewhat broadly pointed at the apices, (17–)18.5–19.9–21.3(-23) × (6–)6.5–7.2–7.9(-8) µm ($n = 36$), l/b 2.5–2.8–3.0(-3.3) ($n = 36$). CONIDIOMATA not observed.

ECOLOGY AND DISTRIBUTION: The species appears to be pathogenic as discoloration is evident and it eventually destroys the host thallus. The species is known only from type locality on the thallus of *Caloplaca crenularia* on siliceous rocks in the western part of Turkey at an elevation 1010 m.

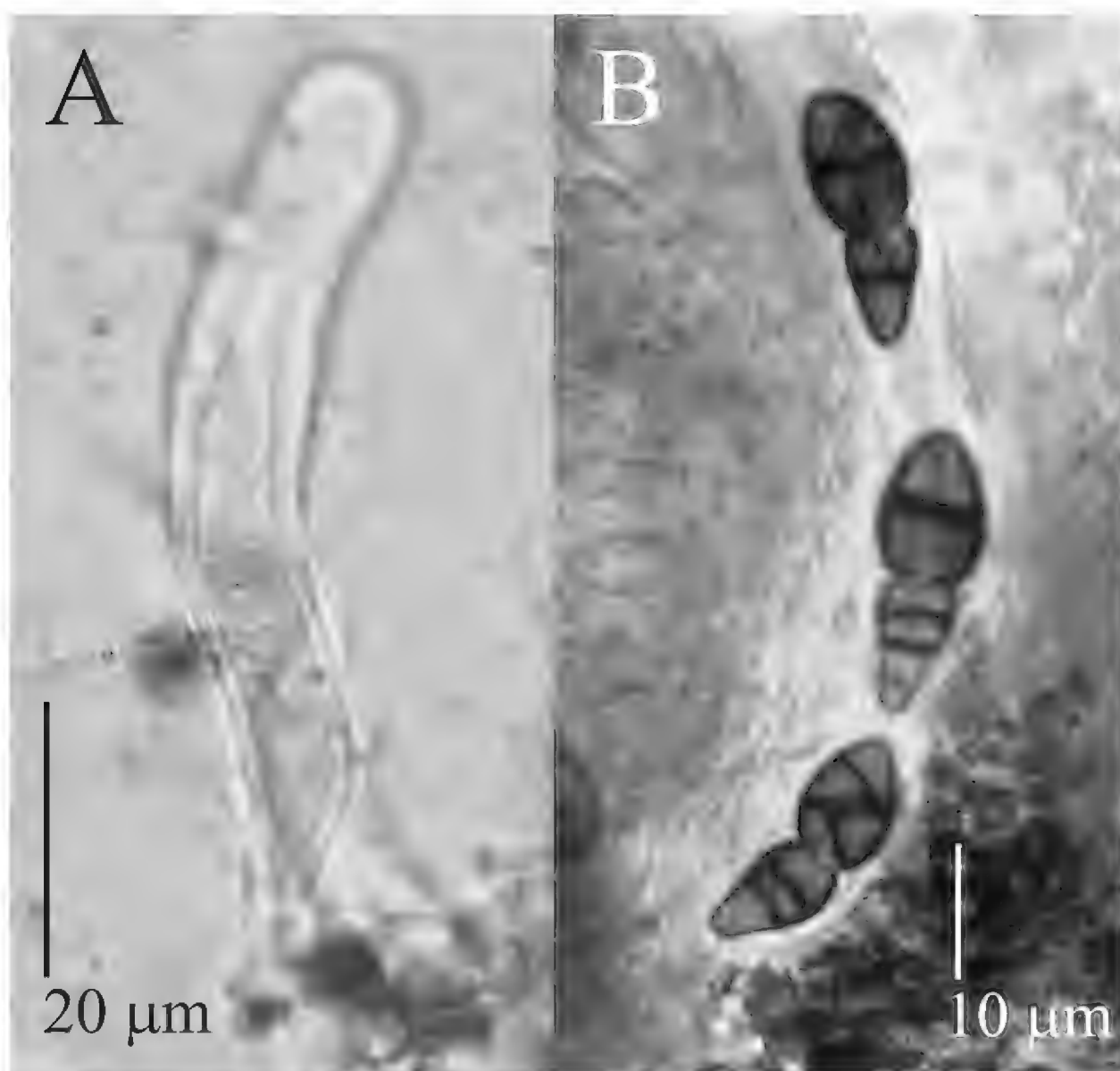


FIG. 1. *Dacampia caloplacicola* (holotype). A, empty ascus; B, ascospores uniseriately arranged in an ascus.

OBSERVATIONS: *Dacampia caloplacicola* is the first species of *Dacampia* recognized as lichenicolous on the genus *Caloplaca*.

The septation and size of ascospores of *Dacampia caloplacicola* [(17–) 18.5–19.9–21.3(–23) \times (6–) 6.5–7.2–7.9(–8) μm vs. 18–25 \times 8–10 μm] and the ascomata sizes [300–500 μm vs. 200–600 μm] are most similar to *D. engeliana* (Saut.) A. Massal., a species known on *Solorina saccata* that does not cause any colored and circular patches on the host thallus (Hawksworth 1986, Halıcı & Hawksworth 2007). *Dacampia rufescentis* (Vouaux) D. Hawksw. (Hawksworth 1986, Halıcı & Hawksworth 2007) and *D. cladoniicola* (Halıcı et al. 2008) have also a similar septation of ascospores, but these are much longer and wider in *D. rufescentis* [(23–) 24.5–27 \times 11–13 μm] and much smaller in *D. cladoniicola* [(9.5–) 10.5–12(–12.5) \times (4.5–) 5.5–6.5 μm], apart from different hosts.

***Dacampia xanthomendozae* Etayo & Halici, sp. nov.**

FIGURE 2

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Dacampia species insignis ascosporis (4–)5-transseptatis et 2–5-longiseptatis, (26.5–)28–30–32(–35.5) × (10.5–)10.9–12–13.1(–13.5) µm, l/b = (2.2)–2.3–2.5–2.7(–2.9).

TYPE COLLECTION: Argentina, Chubut, 5 km near the border with Futaleufú, growing on *Austrocedrus* dispersed amongst *Rosa* bushes, 43°11'19"S, 71°31'45"W, alt. 430 m, on the thallus of epiphytic *Xanthomendoza*, 4 February 2006, leg. J. Etayo 23703 & J. Amigo (BCRU – holotype).

ETYMOLOGY: The epithet "*xanthomendozae*" refers to the host *Xanthomendoza*.

DESCRIPTION: Lichenicolous, on the thallus of *Xanthomendoza*. VEGETATIVE HYPHAE not observed. ASCOMATA perithecioid, arising singly or grouped, immersed to semi-immersed at maturity, 150–200 µm diam, black, subglobose. EXCIPLE composed of several layers of angular pseudoparenchymatous cells, colorless inside, brownish black in the external layers, of textura angularis, 10–20 µm thick, up to 40 µm in the ostiolar region, reddish brown to brown, walls of exciple cells thin, ca. 1 µm thick. HAMATHECIUM of cellular pseudoparaphyses, abundant, septate, branched and anastomosed, 2–3 µm wide; KI, I–. ASCI elongate-clavate, shortly stalked, wall ca. 2 µm thick, with a small ocular chamber, (4–)6-spored at maturity, I–, 73–95 × 16–23 µm ($n = 5$). ASCOSPORES normally biserially arranged in the asci, ellipsoid, golden-brown to brown, muriform, with (4–)5 transsepta and 2–5 longisepta, not constricted medially but slightly constricted at the septa, sometimes with small lipid droplets in each cell, terminal cells concolorous with central cells, rounded to somewhat slightly pointed at the apices, with a verruculose surface, (26.5–)28–30–32(–35.5) × (10.5–)10.9–12–13.1(–13.5) µm ($n = 20$), l/b (2.2)–2.3–2.5–2.7(–2.9) ($n = 20$). CONIDIOMATA not observed.

ECOLOGY AND DISTRIBUTION: The species is clearly pathogenic, producing a blackening on the host thallus and apparently destroying it. The infection is also shared by an unidentified *Arthonia*, more common than *D. xanthomendozae* in the type material. It grows on a sterile *Xanthomendoza* with marginal soredia, small hairs in the lobes and bacillar conidia of 4–5 × 0.5 µm, similar to *X. ulophyllodes* (Räsänen) Söchting et al., growing on isolated and exposed *Austrocedrus* in open bushy areas. It is known only from the type locality in southern Argentina at an elevation of 430 m.

OBSERVATIONS: The large ascospore size of this species approaches it to *D. hookeri* (Borrer) A. Massal., with ascospores of 30–36 × 11–16 µm, and *D. rhizocarpicola* D. Hawksw., with ascospores of (30–)34–37.5(–39) × (10–)14.5–16 µm. The first species has 8-spored asci uniserially arranged, and it grows in close association with *Solorina* thalli (Poelt 1969, Henssen 1995). *D. rhizocarpicola*, apart from growing on *Rhizocarpon obscuratum* (Halici &

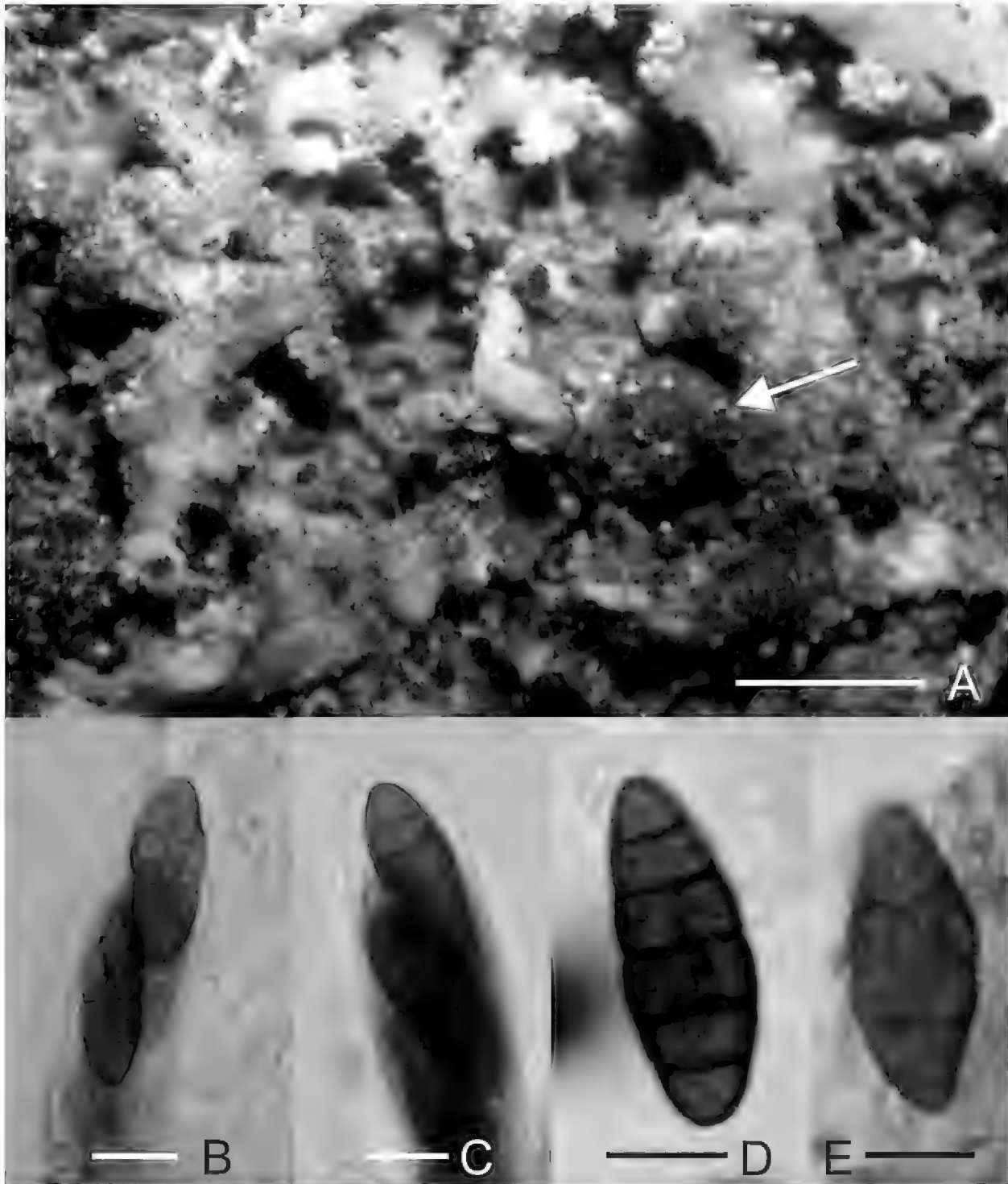


FIG. 2. *Dacampia xanthomendozae* (holotype). A, some ascomata on blackish thallus of the host. B, C, asci apex with ascospores. D, E, ascospores. Scales: A = 0,5 mm; B–E = 10 μ m.

Hawksworth 2008), has 2–4 spored asci and ascospores that are larger and especially wider than those of *D. xanthomendozae*. This is the second known species of *Dacampia* on *Teloschistales*, the first being the above described *D. caloplacicola*, a species that grows on a crustose and saxicolous *Caloplaca* species, and with larger perithecia and smaller, less septate ascospores with a medial constriction.

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Literature cited

- Halıcı MG, Hawksworth DL. 2008. Two new species of *Dacampia* (Ascomycota, *Dacampiaceae*), with a key to and synopsis of the known species of the genus. *Fungal Diversity* 28: 49–54.
- Halıcı MG, Özdemir Türk A, Candan M. 2008. *Dacampia cladoniicola* sp. nov. (Ascomycota, *Dacampiaceae*), on *Cladonia* sp. from Turkey. *Mycotaxon* 103: 53–57.
- Halıcı MG, Candan M, Calatayud V. 2009. *Dacampia rubra* (Ascomycota, *Dacampiaceae*), a lichenicolous fungus on vagrant *Aspicilia* species. *Mycotaxon* 108: 235–240.
- Henssen A. 1995. Studies on the biology and structure of *Dacampia* (*Dothideales*), a genus with lichenized and lichenicolous species. *Cryptogamic Botany* 5: 149–158.
- Hawksworth DL. 1986. Notes on British lichenicolous fungi V. Notes from The Royal Botanical Garden 43: 497–519.
- Poelt J. 1969. Bestimmungsschlüssel europäischer Flechten. J. Cramer, Lehre.

Taxonomic studies of *Helminthosporium* from China 4. Six new species and a key to *Helminthosporium* from China

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Abstract — Six new species of the genus *Helminthosporium* are reported from China: *H. conidiophorellum*, *H. guangxiense*, *H. ligustri*, *H. obpyriform*, *H. ovoideum*, and *H. pseudomicrosorium*. *H. acaciae* is reported for the first time from China. A key to all known *Helminthosporium* species in China is provided. Type specimens are deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP).

Key words — taxonomy, hyphomycetes, saprobes

Introduction

Helminthosporium Link was established based on the type species, *H. velutinum*. It became a repository for a large number of taxa due to a lack of understanding of the generic concepts. Luttrell (1963, 1964) examined the type species and defined the genus as: “Conidia porogenous, distoseptate, maturation holosporous; conidiophores separate or grouped on more or less well developed stromata, conidial scars simple pores or flat ringed pores”. Subsequently, many species were incorporated into other genera, e.g., *Alternaria*, *Bipolaris*, *Cercosporidium*, *Corynespora*, *Drechslera*, *Exserohilum* and *Exosporium* (Alcorn 1988). Ellis (1961) included 10 species in his review, and Siboe et al. (1999) summarized the conidial characteristics of 27 species accepted in the genus. Since then, several additional new species have been described (Shirouzu & Harada 2008, Zhang et al. 2004, 2007). Prior to our studies only two species of *Helminthosporium* had been reported from China: *H. microsorium* D. Sacc. and *H. solani* (Dai 1979, Teng 1996, Lu et al. 2000, Ryu et al. 2001). Our previous research revealed five new species and four new records from China (Zhang et

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al. 2003, 2004, 2007). In this paper we describe six new species and one new record for China. Specimens studied have been deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP). A key to the 18 taxa currently known from China is provided.

Taxonomy

New species

Helminthosporium conidiophorellum Meng Zhang & T.Y. Zhang, sp. nov. FIG. 1

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In substrato naturali mycelium immersum. Stromata partim superficialia, partim immersa, atrobrunnea, pseudoparenchymatica, 25–108 µm alta, 21–64 µm lata. Conidiophora fasciculata ex stromata quoque oriunda, simplicia, subcylindrica, recta vel flexuosa, septata, levia, atrobrunnea, interdum apicem versus pallidiora, 60–280 µm longa, 7–8.5 µm crassa, poris conidiiferis ad apicem et infra 1–2 septa supera praedita. Conidia per poros ad apicem conidiophori prodientia vel infra septa supera lateraliter oriunda, subulata, recta vel flexuosa, levia, infuscata, 11–17-distoseptata, interdum verruculosis ad apicem, 100–147.5 µm longa, 9.5–11 µm crassa, apicem versus ad 3–4 µm gradatim attenuata, basi cicatrice majuscula fusca vel atra praedita.

HOLOTYPE: On dead branches of an unidentified tree, Nanning, Guangxi, China, 23 X 2002, coll. T.Y. Zhang & Y.M. Wu, HSAUP02 0688 (= ZW02 0688).

ETYMOLOGY: referring to the small conidiophore.

Mycelium immersed in the substrata. Stromata partly superficial, partly immersed in the substrata, dark brown, pseudoparenchymatous, 25–108 µm tall, 21–64 µm diam. Conidiophores arising in fascicles from the upper cells of the stromata, simple, subcylindrical, straight or flexuous, thick-walled, smooth, dark brown, paler towards the apex, 60–280 µm long, 7.0–8.5 µm diam, with 1–3 well-defined small pores (conidiogenous loci) at the apex and a few formed laterally just beneath the upper 1–2 septa. Conidia arising through pores at the apex of the conidiophore and laterally beneath the upper septa, straight or slightly flexuous, subulate, smooth-walled, pale brown, sometimes verruculose at apex, 11–17-distoseptate, 100–147.5 µm long, 9.5–11 µm diam in the widest part, narrowing towards the apex to 3–4 µm diam, with a large dark blackish-brown scar at the base, 2–3 µm thick.

COMMENTS: In conidial shape and presence of stromata *Helminthosporium conidiophorellum* resembles *H. dalbergiae* M.B. Ellis (Ellis 1961). However, *H. dalbergiae* has larger (58–125 × 12–14 µm) conidia and broader (10–12 µm diam) conidiophores. Although *H. conidiophorellum* conidial morphology somewhat resembles that of *H. longisinuatum* Matsush. (Matsushima 1993) and *H. kakamegense* Siboe et al. (Siboe et al. 1999), *H. kakamegense* conidia are smaller (30–90 × 8–10 µm) and *H. longisinuatum* has S-shaped conidia and smaller (20–75 × 3.5–5.0 µm) conidiophores.

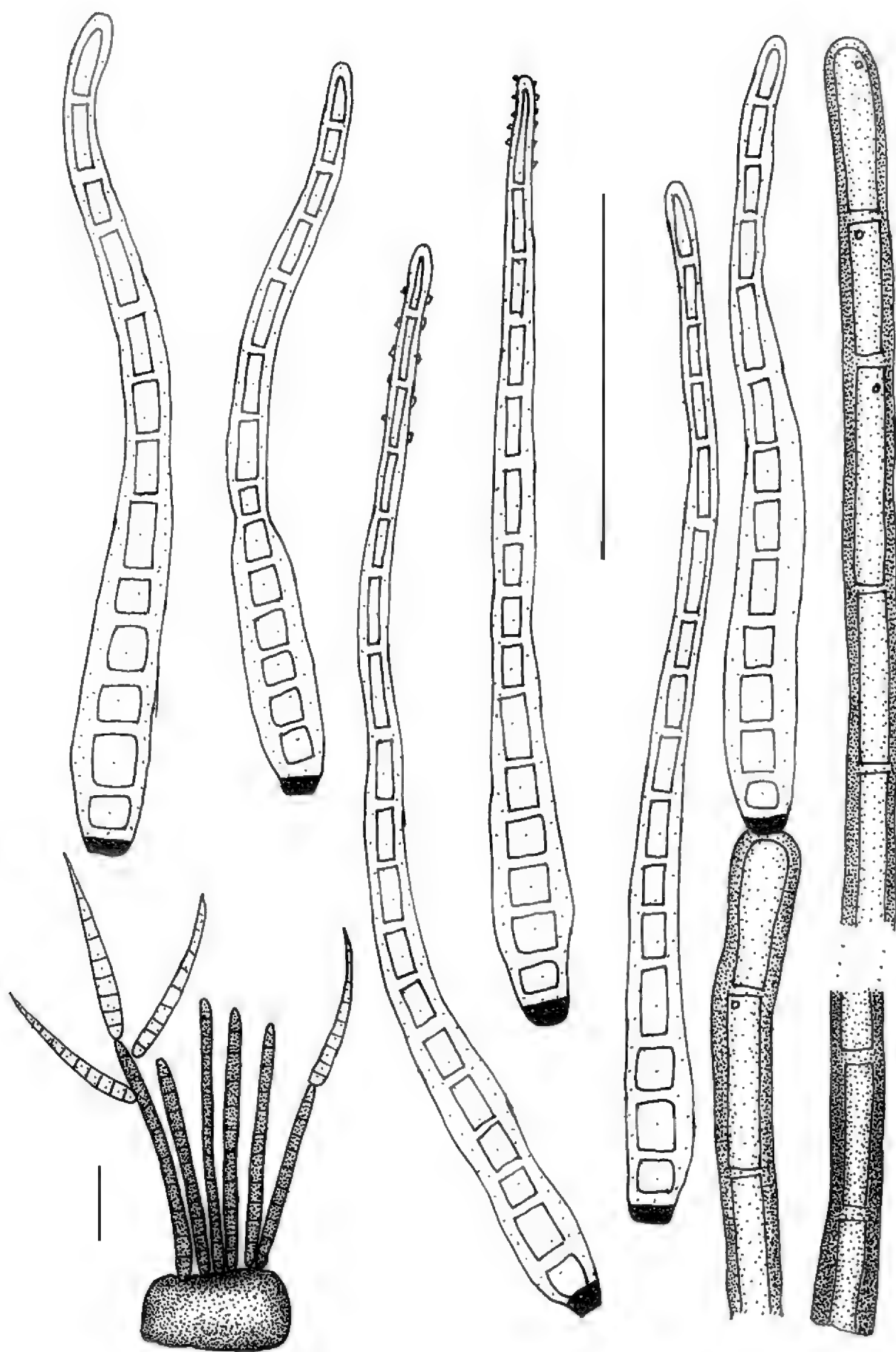


FIG.1 *Helminthosporium conidiophorellum* (bars=50 μ m)
Conidia, conidiophores, and stromata on natural substratum

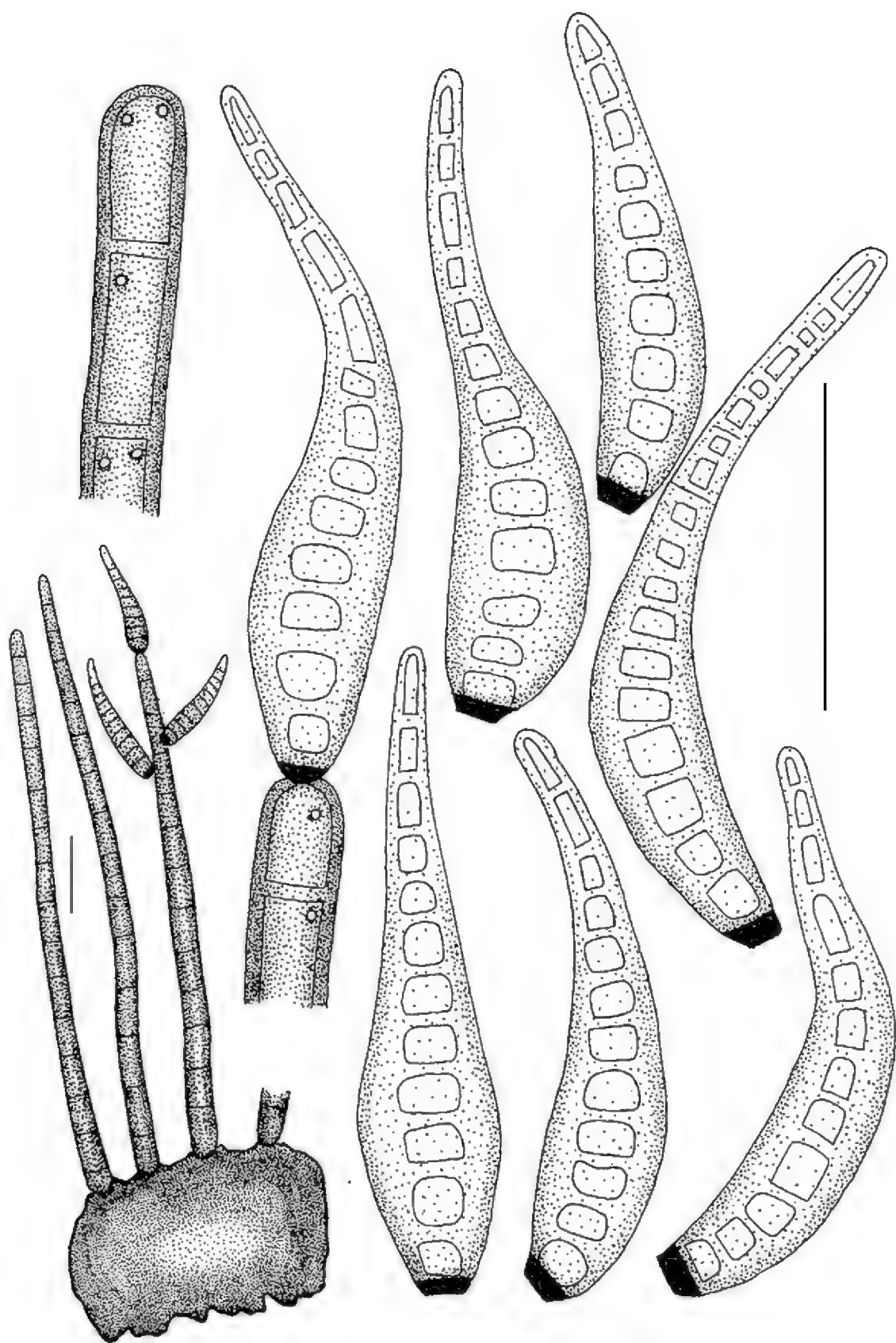


FIG. 2 *Helminthosporium guangxiense* (ex holotype, bars=50 μ m)
Conidia, conidiophores, and stromata on natural substratum

***Helminthosporium guangxiense* Meng Zhang & T.Y. Zhang, sp. nov.**

FIG. 2

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In substrato naturali mycelium immersum. Stromata partim superficialia, partim immersa, atrobrunnea, pseudoparenchymatica, usque ad 60 µm alta, usque ad 129 µm lata. Conidiophora fasciculata ex stromate quoque oriunda, simplicia, recta vel flexuosa, subcylindrica, septata, levia, atrobrunnea, interdum apicem versus pallidiora, 330–850 µm longa, basi 15–20 µm crassa, apice 8–13 µm crassa, poris conidiiferis ad apicem et infra 1–4 septa supera praedita. Conidia per poros ad apicem conidiophori prodientia vel infra septa supera lateraliter oriunda, recta vel curvata, obclavata, levia, moderate brunnea, apicem versus pallidiora, 9–17-distoseptata, 76–110 µm longa, 16–22 µm crassa, apicem versus ad 3–6 µm gradatim attenuata, basi cicatrice majuscula fusca vel atra praedita.

HOLOTYPE: On dead branches of an unidentified tree, Damingshan, Shanglin, Guangxi, China, 18 XII 1997, coll. W.P. Wu, HSAUP 01352 (=WWP 1398a).

ETYMOLOGY: Named for the collection locality (province).

Mycelium immersed in the substratum. Stromata partly superficial, partly immersed, dark brown, pseudoparenchymatous, up to 60 µm tall, 129 µm wide. Conidiophores arising in fascicles from the upper cells of the stromata, simple, straight or flexuous, septa at 15–45 µm intervals, thick-walled, sub-cylindrical, smooth, brown, 330–850 µm long, 15–20 µm wide just above the base and 8–13 µm wide toward the apex, with 1–3 well-defined small pores at the apex and a few formed laterally beneath the upper 1–4 septa. Conidia straight or curved, obclavate, smooth, middle brown, paler towards the apex, 9–17-distoseptate, 76–110 µm long, 16–22 µm wide in the widest part, narrowing towards the apex to 3–6 µm wide, with a large dark blackish-brown scar at the base, 1.5–3.5 µm thick.

COMMENTS: *Helminthosporium guangxiense* is most closely related in conidial morphology (obclavate shape and size) to *H. microsorum* D. Sacc. and *H. pseudomicrosorum*, which can be separated mainly by having more narrow conidiophores (100–550 × 8–14 µm in *H. microsorum*; 155–288 × 11–15 µm in *H. pseudomicrosorum*). In addition, *H. guangxiense* conidiophores are subcylindric (base thicker than apex) compared to the cylindric (base same width as apex) conidiophores characteristically found in *H. microsorum* and *H. pseudomicrosorum*. The conidia of *H. guangxiense* are also thinner than those of *H. pseudomicrosorum* [17–27 µm thick].

***Helminthosporium ligustri* Meng Zhang & T.Y. Zhang, sp. nov.**

FIG. 3

MYCOBANK MB 513227

In substrato naturali mycelium immersum. Stromata absentia. Conidiophora singularia, simplicia, subcylindrica, recta vel flexuosa, septata, levia vel verruculosa, atrobrunnea, apicem versus pallidiora, crassi tunicata, 127–700 µm longa, ad basim ad 9.5–18 µm crassa, supra basim 8.5–10 µm crassa, poris conidiiferis ad apicem et infra 1–4 septa supera praedita. Conidia per poros ad apicem conidiophori prodientia vel infra septa

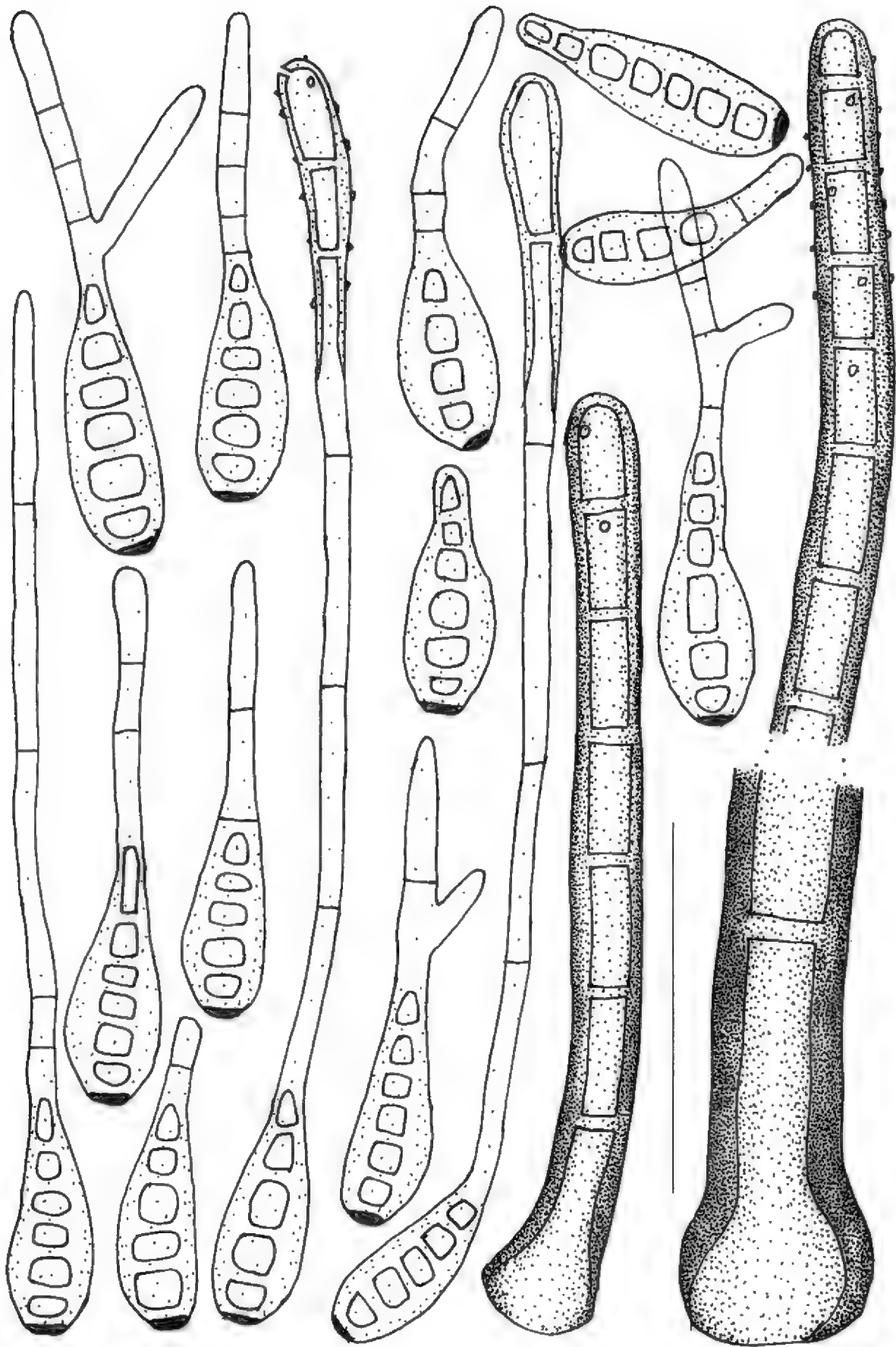


FIG. 3 *Helminthosporium ligustri* (bar= 50 μ m)
Conidia and conidiophores on natural substratum

supera lateraliter oriunda, recta vel leviter flexuosa, obclavata, levia, pallide brunnea, 4–6-distoseptata, 24–38.5 × 9.5–13 µm, rostra vel pseudorostra simplicia vel ramosa, subcylindrica, septata, levia, subhyalinis vel pallide brunnea, usque ad 1000 µm longa, 3–4.5 µm crassa, apice leviter inflata, 8.5 µm crassa, levia vel verruculosa, basi cicatrice majuscula fusca vel atra praedita.

HOLOTYPE: On dead branches of *Ligustrum quihoui* Carrière, Nanning, Guangxi, China, 23 X 2002, coll. T.Y. Zhang & Y.M. Wu, HSAUP₀₂ 0516 (=ZW₀₂ 0516).

ETYMOLOGY: Named for the substrate, *Ligustrum quihoui*.

Mycelium immersed in the substrata. Stromata not formed. Conidiophores solitary, simple, straight or flexuous, septate, smooth or verruculose, thick-walled, dark brown, 127–700 µm long, 9.5–18 µm diam just above the base and 8.5–10 µm diam towards the apex, with 1–3 well-defined small pores at the apex and a few formed laterally beneath the upper 1–4 septa. Conidia arising through pores at the apex of the conidiophore and laterally beneath the upper septa, straight or slightly curved, obclavate, rostrate or pseudorostrate, smooth-walled, pale brown, subhyaline towards the apex, 4–6-distoseptate, 24–38.5 × 9.5–13 µm with a large dark blackish-brown scar at the base, 1–2 µm thick. Rostra or pseudorostra simple or sometimes branched, subcylindrical, septate, smooth, subhyaline to pale brown, up to 1000 long, 3–4.5 µm diam, apex inflated to 8.5 µm diam, smooth or verruculose.

COMMENTS: *Helminthosporium spurirostrum* Meng Zhang et al. (Zhang et al. 2004) also has pseudorostrate conidia. However, *H. ligustri* is characterized by having verruculose and frequently branched pseudorostra.

***Helminthosporium obpyriforme* Meng Zhang & T.Y. Zhang, sp. nov.**

FIG. 4

MYCOBANK MB 513228

In substrato naturali mycelium immersum. Stromata partim superficialia, partim immersa, atrobrunnea, pseudoparenchymatica, av. ad 16 µm alta, av. ad 22 µm lata. Conidiophora singularia, ex stromata quoque oriunda, simplicia, recta vel flexuosa, subcylindrica, septata, levia, atrobrunnea, interdum apicem versus pallidiora, 225–460 µm longa, basi 9.5–13 µm crassa, apice 6–8.5 µm crassa, poris conidiiferis ad apicem et infra 1–3 septa supera praedita. Conidia per poros ad apicem conidiophori prodientia vel infra septa supera lateraliter oriunda, obpyriformis, recta vel leviter curvata, levia, medio-brunnea, apicem versus pallidiora, 5–9-distoseptata, 47–74 µm longa, 14–19 µm crassa, apicem versus ad 2.5–5 µm gradatim attenuata, basi cicatrice majuscula fusca vel atra praedita.

HOLOTYPE: On dead branches of an unidentified tree, Guangxi, China, 28 XII 1997, coll. W.P. Wu, HSAUP₀₁ 0354 (=WWP 1502c).

ETYMOLOGY: referring to the slightly pear-shaped conidia.

Mycelium immersed in the substrata. Stromata partly superficial, partly immersed in the substratum, dark brown, pseudoparenchymatous, av. 16 µm tall, 22 µm wide. Conidiophores arising singly from the upper cells of the stromata, simple, subcylindrical, straight or flexuous, thick and smooth-walled,

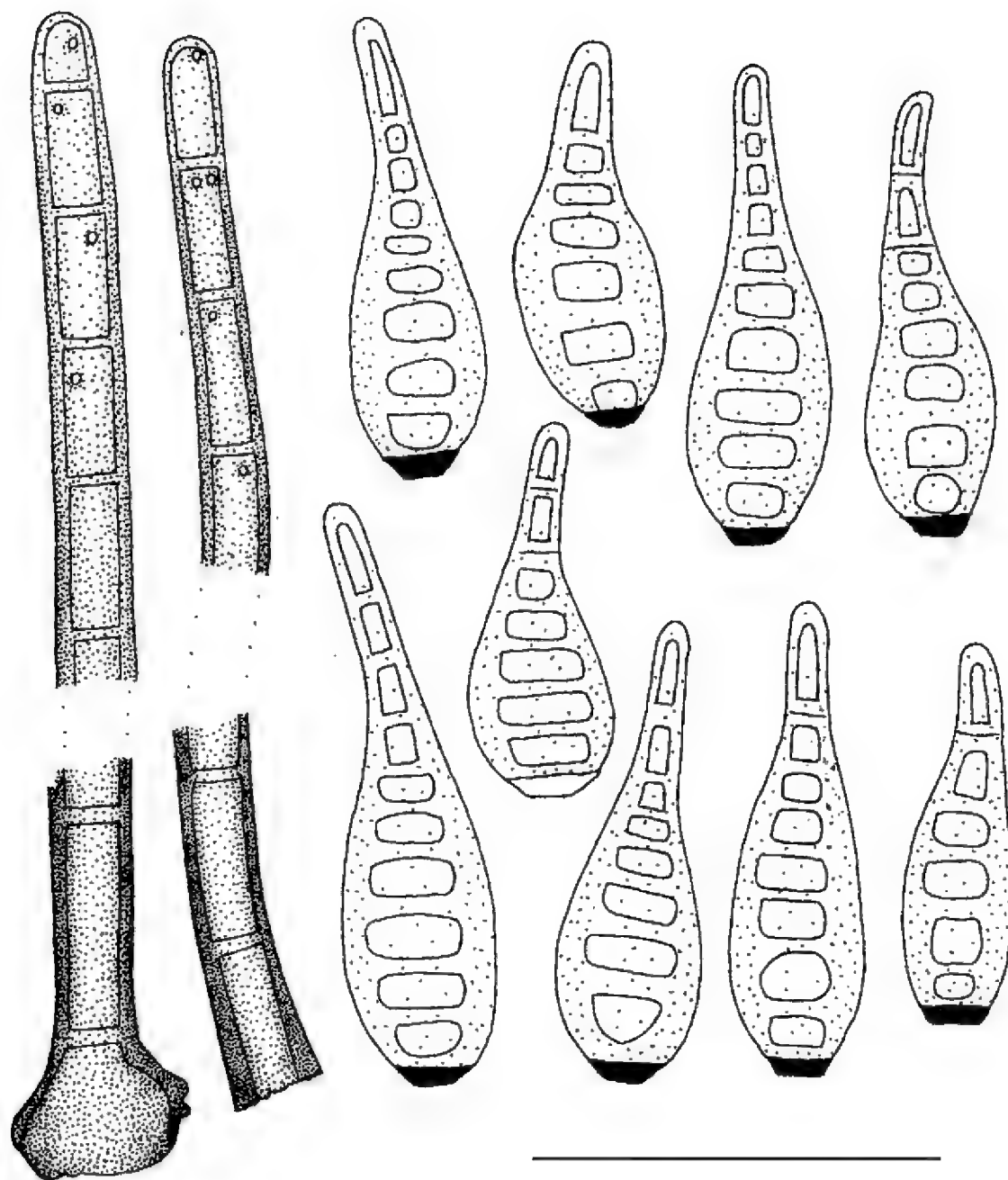


FIG. 4 *Helminthosporium obpyriforme* (ex holotype, bar=50µm)
Conidia and conidiophores on natural substratum

dark brown, paler towards the apex, 225–460 µm long, 9.5–13 µm diam just above the base and 6–8.5 µm diam towards the apex, with well-defined small pores at the apex and a few formed laterally beneath the upper 1–3 septa. Conidia arising through pores at the apex of the conidiophore and laterally beneath the upper septa, straight or slightly curved, obpyriform, smooth-walled, middle brown, paler towards the apex, 5–9-distoseptate, 47–74 µm long, 14–19 µm diam in the widest part, narrowing in diameter towards the apex to 2.5–5 µm, with a large dark blackish-brown scar at conidium base, 1–2 µm thick.

COMMENTS: The *Helminthosporium obpyriforme* conidial size range overlaps with that of *H. velutinum* Link (Ellis 1961), but *H. obpyriforme* conidia are obpyriform and shorter and thicker than the obclavate *H. velutinum* conidia (48–118 × 11–20 µm, av. = 68 × 15 µm). Furthermore, the *H. velutinum* conidiophores are broader (250–950 µm long, 14–26 µm wide just above the base and 8.5–12 µm wide toward the apex).

***Helminthosporium ovoideum* Meng Zhang & T.Y. Zhang, sp. nov.**

FIG. 5

MYCOBANK MB 513229

In substrato naturali, mycelium immersum. Stromata partim superficialia, partim immersa, atro-brunnea, pseudoparenchymatica, usque ad 34.5 µm alta, usque ad 45.5 µm lata. Conidiophora singularia ex stromate quoque oriunda, simplicia, recta, subcylindrica, septata, levia, brunnea vel atro-brunnea, interdum apicem versus pallidiora, 380–510 µm longa, basi 15–25 µm crassa, apice 7.5–10 µm crassa, poris conidiiferis ad apicem et infra 1–6 septa supera praedita. Conidia per poros ad apicem conidiophori prodientia vel infra septa supera lateraliter oriunda, recta, ovoidea vel elliptica, levia, brunnea, apicem versus pallidiora, 3–8-pseudoseptata, 27–61 µm longa, 13–21 µm crassa, apicem versus ad 4.5–8.5 µm gradatim attenuata, basi cicatrice majuscula fusca vel atra praedita.

HOLOTYPE: On dead branches of an unidentified tree, Changbaishan, Jilin Province, China, 5 IX 1998, coll. W.P. Wu, HSAUP₀₁ 0362 (=WWP 1729).

ETYMOLOGY: referring to the ovoid conidial shape.

Mycelium immersed in the substrata. Stromata partly superficial, partly immersed in the substrata, dark brown, pseudoparenchymatous, up to 35 µm tall, 45 µm wide. Conidiophores arising singly from the upper cells of the stromata, simple, subcylindrical, straight or flexuous, thick-walled, smooth, brown to dark brown, paler towards the apex, 380–510 µm long, 15–25 µm diam just above the base and 7.5–10 µm diam towards the apex, with 1–3 well-defined small pores (conidiogenous loci) at the apex and a few laterally beneath the upper 1–6 septa. Conidia arising through pores, straight, ovoid, to ellipsoidal, smooth-walled, moderately brown, paler towards the apex, 3–8-distoseptate, 27–61 µm long, 13–21 µm diam in the widest part, narrowing towards the apex to 4.5–8.5 µm, with a large dark blackish-brown scar at the base, 1.5–2.5 µm thick.

COMMENTS: The most similar species in conidium size are *Helminthosporium acaciae*, *H. mauritianum* Cooke and *H. kalopanacis* Gornostaï (Siboe et al. 1999). However, conidium shape and width can be used to distinguish these species. The conidia of *H. ovoideum* are ovoid to ellipsoidal, while those of the other three are obclavate or cylindrical. The conidia of *H. ovoideum* are thicker than those of *H. acaciae* (10–15 µm diam), *H. mauritianum* (8–13 µm diam), and *H. kalopanacis* (10–17 µm diam).

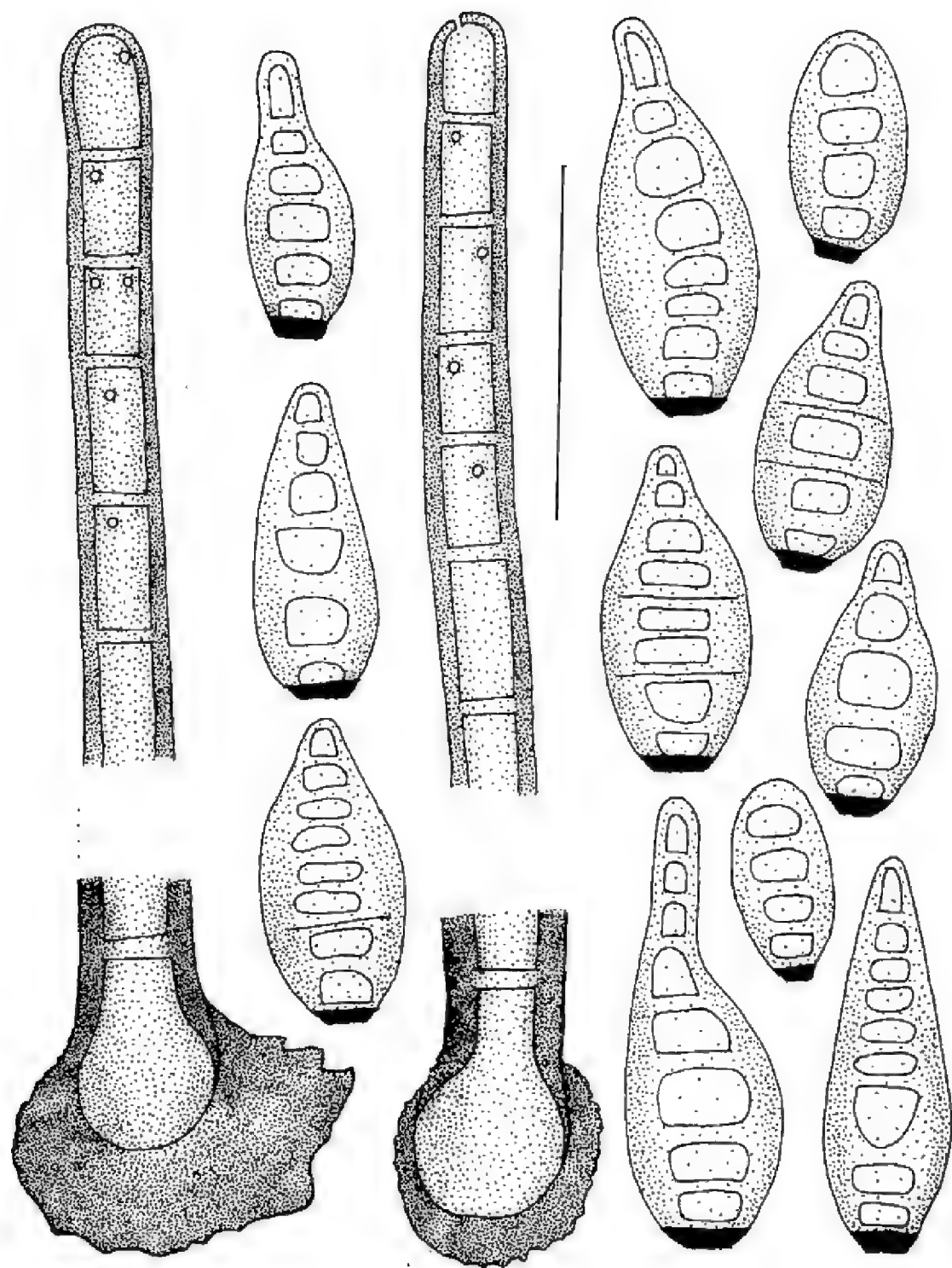


FIG. 5 *Helminthosporium ovoideum* (ex holotype, bar = 50µm)
Conidia and conidiophores on natural substratum.

Helminthosporium pseudomicrosorum Meng Zhang & T.Y. Zhang, sp. nov. FIG. 6
MYCOBANK MB 513230

In substrato naturali mycelium immersum. Stromata partim superficialia, partim immersa, atro-brunnea, pseudoparenchymatica, usque ad 86 µm alta, usque ad 45 µm lata. Conidiophora fasciculata ex stromate quoque oriunda, simplicia, recta vel flexuosa, cylindrica, septata, levia, atro-brunnea, interdum apicem versus pallidiora, 155–288 µm

longa, 11–15 µm crassa, poris conidiiferis ad apicem et infra 1–4 septa supera praedita. Conidia per poros ad apicem conidiophori prodientia vel infra septa supera lateraliter oriunda, recta vel flexuosa, obclavata, levia, brunnea, apicem versus pallidiora, 7–16-distoseptata, 82–142 µm longa, 17–27 µm crassa, apicem versus ad 3–6 µm gradatim attenuata, basi cicatrice majuscula fusca vel atra praedita.

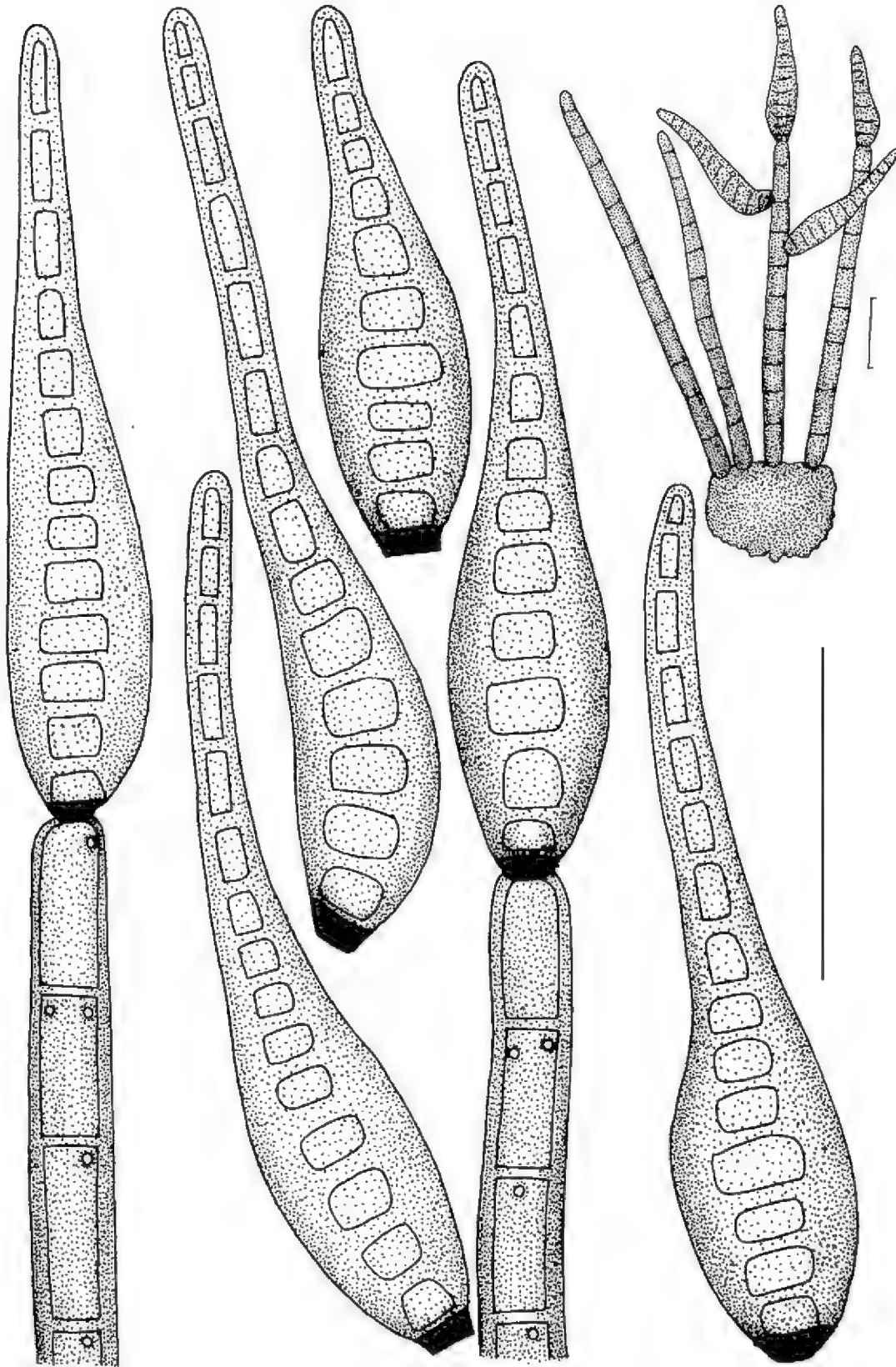


FIG. 6 *Helminthosporium pseudomicrosorium* (ex holotype, bars = 50 µm).
Conidia and conidiophores on natural substratum.

HOLOTYPE: On dead branches of an unidentified tree, Changbaishan, Jilin Province, China, 5 IX 1998, coll. W.P. Wu, HSAUP₀₁ 0365 (= WWP 1747).

ETYMOLOGY: referring to the similarity to *H. microsorum*

Mycelium immersed in the substratum. Stromata partly superficial, partly immersed in the substratum, dark brown, pseudoparenchymatous, up to 85 µm tall, 45 µm wide. Conidiophores arising in fascicles from the upper cells of the stromata, simple, cylindrical, straight or flexuous, thick-walled, smooth, dark brown, paler towards the apex, 155–288 µm long, 11–15 µm diam, with 1–3 well-defined small pores (conidiogenous loci) at the apex and a few formed laterally beneath the upper 1–4 septa. Conidia tretic, arising through pores at the apex of the conidiophore and laterally beneath the upper septa, straight or slightly flexuous, obclavate, smooth-walled, brown, paler towards the apex, 7–16-distoseptate, 82–142 µm long, 17–27 µm diam in the widest part, narrowing towards the apex to 3–6 µm diam, with a large dark blackish-brown scar at the base, 2–4 µm thick.

COMMENTS: To some extent *Helminthosporium pseudomicrosporum* resembles *H. microsorum* and *H. ahmadii* M.B. Ellis in its obclavate conidia. However, *H. microsorum* conidia are narrower (12–22 µm diam) while those of *H. ahmadii* are wider (25–30 µm diam).

New record

Helminthosporium acaciae M.B. Ellis, Mycological Papers 82: 9, 1961. FIG. 7

Mycelium immersed in the substratum. Stromata usually immersed. Conidiophores arising singly or in fascicles from the upper cells of the stromata, simple, straight or flexuous, septate in 15–35 µm intervals, smooth or verruculose, thick-walled, brown, 300–800 µm long, 7.5–13.5 µm wide just above the base and 7.5–10 µm diam towards the apex, with 1–3 well-defined small pores (conidiogenous loci) at the apex and a few laterally beneath the upper 1–5 septa. Conidia arising through the pores, straight or slightly curved, obclavate, ovoid to obpyriform, smooth-walled, pale brown, paler towards the apex, 5–9-distoseptate, 29–53 µm long, 10–15 µm diam in the widest part, narrowing towards the apex to 3–5 µm, with a large dark blackish-brown scar at the base, 1.5–2.5 µm thick.

SUBSTRATE: On dead branches of unidentified tree, Kunming, Yunnan Province, 23 Oct. 1999, Coll. W.P. Wu, HSAUP₀₁ 0377 (= WWP 2533a).

COMMENTS: The Chinese collection is similar to the original description by Ellis (1961). However, the conidiophores are verruculose and longer than the original description. The roughened surface of some conidiophores should be a new characteristic of this species

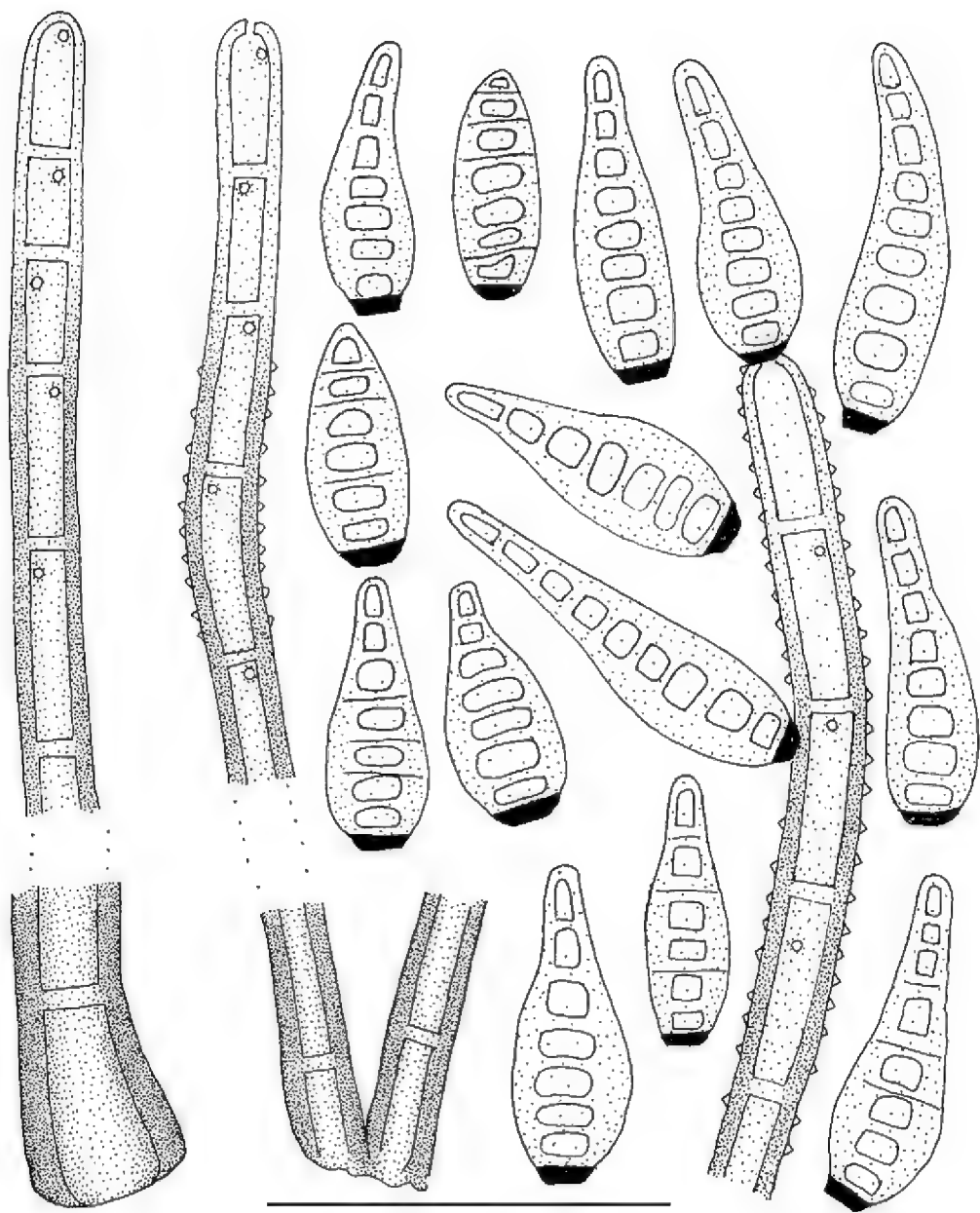


FIG. 7 *Helminthosporium acaciae* (bar =50 μ m).
Conidia and conidiophores on natural substratum.

Key to the species of *Helminthosporium* from China

- 1. Conidia thin and long, subulate or nearly whip-like 2
 Conidia short and thick, neither subulate nor whip-like 6
- 2. Conidiophores arising from pseudostromata 90–280 μ m tall on natural
 substrata 3
 Pseudostromata relatively small (< 30 μ m tall) on natural substrata 4
- 3. Conidia average more than 15 μ m diam, brown, smooth *H. microsorum*
 Conidia average less than 15 μ m diam, pale brown, sometimes verruculose
 at apex *H. conidiophorellum*
- 4. Conidia often constricted at one or two central septa *H. constrictum*
 Conidia not constricted at septa, gradually thinner from the base towards apex ... 5

5.	Conidia subhyaline, 6–9-distoseptate	<i>H. subhyalinum</i>
	Conidia pale brown, with 13–25-distoseptate	<i>H. multiseptatum</i>
6.	Conidia long ellipsoidal, nearly fusiform, often curved to one side	7
	Conidia obclavate, obpyriform or nearly ovoid, gradually thinner from middle to top	8
7.	Conidia sometimes in short chains (secondary conidia produced), 5–8 µm diam at widest part	<i>H. senseletii</i>
	Conidia solitary, 7–10 µm diam at widest part	<i>H. palmigenum</i>
8.	Conidia obpyriform	<i>H. obpyriforme</i>
	Conidia not obpyriform	9
9.	Conidia ovoid to broadly obclavate	10
	Conidia obclavate	11
10.	Conidia mostly typical ovoid, 3–8-distoseptate; conidiophores smooth	<i>H. ovoideum</i>
	Conidia ovoid to broadly obclavate, 5–9-distoseptate; conidiophores sometimes verruculose	<i>H. acaciae</i>
11.	Conidia rostrate or pseudorostrate	12
	Conidia not rostrate or pseudorostrate	13
12.	Conidia rostrate, up to 1000 µm long, subhyaline, sometimes the conidial apex pseudorostrate and secondary conidia produced	<i>H. ligustri</i>
	Conidium apex often pseudorostrate, conidia of two types: (a) relatively large (52–73 × 12–15.5 µm); (b) relatively small (27–41 × 9.5–13 µm), secondary conidia produced	<i>H. spurirostrum</i>
13.	Conidia relatively large, average length and width more than 75 µm and 16.5µm, respectively	14
	Conidia relatively small, average length and width less than 70 µm and 16 µm, respectively	16
14.	The apical septa of conidia obviously constricted, with cylindrical rostra	<i>H. bauhiniae</i>
	Conidia gradually thinner from middle to top, not obviously constricted at septa	15
15.	Average length of conidia more than 120 µm, straight or slightly flexuous	<i>H. pseudomicrosorum</i>
	Average length of conidia less than 100 µm, often flexuous to one side	<i>H. guangxiense</i>
16.	Conidia diameter averages 15 µm	<i>H. velutinum</i>
	Conidia diameter averages 12 µm	<i>H. sichuanense</i>
	Conidia diameter averages 8.5 µm	<i>H. solani</i>

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Literature cited

- Alcorn JL. 1988. The taxonomy of “*Helminthosporium*” species. *Ann. Rev. Phtopathol.* 26: 37–56.
- Dai FL. 1979. *Sylloge Fungorum Sinicorum*. Science Press, 1–1527.
- Ellis MB. 1961. Dematiaceous hyphomycetes III. *Mycological Papers* 82: 1–55
- Lu BS, Hyde KD, Ho WH, Taylor JE, Tsui KM, Wong MKM, Yanna and Zhou DQ. 2000. Checklist of Hong Kong fungi. *Fungal Diversity Research Series* 5: 1–207.
- Luttrell ES. 1963. Taxonomic criteria in *Helminthosporium*. *Mycologia* 55: 643–674.
- Luttrell ES. 1964. Systematics of *Helminthosporium* and related genera. *Mycologia* 56: 119–132.
- Matsushima T. 1993. *Matsushima Mycological Memoirs No. 7. Matsushima Fungus Collection*, Kobe, Japan: p. 53.
- Ryu KY, Luo WF, Yang YL, Chen HR, Guo HC. 2001. Occurrence of silver scurf disease caused by *Helminthosporium solani* in Yunnan province. *Chinese Potato* 15(4): 195–199.
- Shirouzu T, Harada Y. 2008. Lignicolous dematiaceous hyphomycetes in Japan: five new records for Japanese mycoflora, and proposals of a new name, *Helminthosporium magnisporum*, and a new combination, *Solicorynespora foveolata*. *Mycoscience* 49(2): 126–131.
- Siboe GM, Kirk PM, Cannon PF. 1999. New dematiaceous hyphomycetes from Kenyan rare plants. *Mycotaxon* 73: 283–302.
- Teng SC. 1996. *Fungi of China*. Mycotaxon, New York, USA: 586pp.
- Zhang M, Zhang TY, Wu WP. 2003. Taxonomic studies of *Helminthosporium* from China I. Some new records. *Mycosystema* 22 (Supplement): 77–79.
- Zhang M, Zhang TY, Wu WP. 2004. Taxonomic studies of *Helminthosporium* from China II. Two new species in Sichuan Province. *Mycosystema* 23: 179–182.
- Zhang M, Zhang TY, Wu WP. 2007. Taxonomic studies of *Helminthosporium* from China III. Three new species in Guangdong Province. *Mycotaxon* 99: 137–142.

Some pyrenomycetous fungi new to China

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Abstract — Nine new records of pyrenomycetous fungi from China are reported. Most of these were known previously only from eastern Russia. *Melanconis marginalis* (and not *M. alni*) is recognized as occurring on *Duschekia* spp. in the northern portion of eastern Asia, and *Diatrype macounii* is acknowledged as distinct from *D. bullata*.

Key words — *Sordariomycetes*, taxonomy

Introduction

The eastern portion of Asia along the Pacific coast between 35 and 50 degrees north latitude is a unique territory that is characterized by the presence of a distinct assemblage of pyrenomycetous fungi. Evidence for this is the large number of new genera and species described from eastern Russia in recent years (Ju et al. 1999, 2009; Vasilyeva 2001, 2007; Stadler et al. 2005; Vasilyeva & Stephenson 2007; Vasilyeva & Stadler 2008). These taxa might be expected to occur in the northeastern portion of China where similar types of vegetation are found.

The pyrenomycetous fungi (*Sordariomycetes*, *Ascomycota*: Lumbsch & Huhndorf 2007) are poorly investigated in northeastern China. Thus, Teng (1939) reported nine species for Heilongjiang Province and 17 species for Jilin (Kirin) Province, with a total of 23 species for both provinces. Later, 25 species for these two provinces were added (Kobayashi & Zhao 1989, Doi et al. 2001, Bau 2005, Dai & Bau 2007). Still later, three new species (*Leucodiaporthe*

juglandis Lar.N. Vassiljeva, *Leucostoma pseudoniveum* Lar.N. Vassiljeva, *Phragmodiaporthe padi* Lar.N. Vassiljeva) were described from Heilongjiang Province, and two new species [*Diaporthella corylina* Lar.N. Vassiljeva, *Leucodiaporthe maackii* (Lar.N. Vassiljeva) M.E. Barr & Lar.N. Vassiljeva] described from adjacent areas in Russia were also found in the latter province (Vasilyeva et al. 2007). Another species (*Xylaria primorskensis* Y.M. Ju et al.) was added recently (Ju et al. 2009).

This paper was prepared when the monograph “Fungi of Ussuri River Valley” was submitted for publication. The latter contains check-lists of various groups of fungi, and 27 species of pyrenomycetes are reported from China for the first time, although many of these are widely distributed. Collectively, 81 pyrenomycetous species were listed as occurring in northeastern China, and an additional 9 new records are described in this paper. Most of the latter lacked English descriptions before and were known only from eastern Russia. In contrast, *Melanconis marginalis* has a wider known distribution, but its occurrence in China entailed the re-identification of all east-Asian specimens of ‘*Melanconis alni*’ collected previously. *Diatrype macounii* is included herein because of contradictory opinions about its taxonomic status.

Material and methods

The material considered in this paper was collected by the first author in 2003–04 (Heilongjiang Province) during field surveys carried out by mycologists of the Institute of Biology and Soil Science, Far East Branch of the Russian Academy of Sciences, Vladivostok (Russia), and the Institute of Mycology, Jilin Agricultural University, Changchun (China) in the context of a joint project entitled “Studies of fungi in Ussuri River Valley”. Additional specimens were collected in 2008 (Jilin Province) during an excursion to the Changbai Mountain that took place after the China-Japan Pan Asia Pacific Mycology Forum. Relevant specimens collected earlier in Russia and Japan are also included. All specimens are deposited in the Herbarium of the Institute of Biology and Soil Science (VLA). Microscopic analyses were carried out using standard techniques. Photographs were taken using a Nikon D40x (with DG macro-objective SIGMA EX 105 mm F2.8) digital camera and Leica MZ75 and Leica DM 4500B microscopes.

The new records

1. *Biscogniauxia mandshurica* Lar.N. Vassiljeva,

Nizshie Rasteniya, Griby i Mokhoobraznye Dalnego Vostoka Rossii, Griby.

Tom 4. Pirenomitsety i Lokuloaskomitsety (Sankt-Petersburg): 84 (1998) FIG. 1

Stromata erumpent from the bark, discoid to elliptical, 5–7 mm diam., mostly solitary, surface slightly concave, sometimes flat, grayish brown or black,

smooth, ostioles umbilicate, rarely finely papillate and often surrounded by a ring-like shallow furrow; margins dark brown, distinctly raised, irregularly dentate, originating from outer dehiscing layer. Perithecia obovoid to tubular, 0.5–0.7 mm high, 0.3–0.4 mm wide. Asci cylindrical, $80\text{--}90 \times 5\text{--}6 \mu\text{m}$. Ascospores brown, unicellular, narrow-elliptical, $8\text{--}12(-13) \times 3.5\text{--}4 \mu\text{m}$, with straight germ slit spore length.

SPECIMENS EXAMINED: CHINA. Jilin Province: Changbai Mountain, dead branch of *Malus* sp., 4.VIII.2008, VLA P-2290. – JAPAN. Tochigi Prefecture: Chuzenziko Lake, dead branch of *Malus* sp., 25.VI.1999, VLA P-1431. – RUSSIA. Primorsky Territory: Sikhote-Alinsky Nature Reserve, dead branches of *M. manshurica* (Maxim.) Kom., 3.VIII.1985 (HOLOTYPE); Lazovsky Nature Reserve, dead branches of *M. manshurica*, 23.VII.1986, VLA P-1769; Kedrovaya Pad Biosphere Reserve, dead branches of *M. manshurica*, 20.X.1987, VLA P-1770; Ussuriysk Nature Reserve, dead branches of *M. manshurica*, 27.VIII.1989, VLA P-41; Amur Region: Khingansky Nature Reserve, dead branches of *M. baccata* (L.) Borkh., 28.VIII.1992, VLA P-1771; Blagoveshchensk vicinity, dead branches of *M. baccata*, 31.VIII.1999, VLA P-1772.

COMMENTS—The record of *B. mandshurica* for Japan included herein is also the first one for that country. A complex of closely related species of *Biscogniauxia* occurs in eastern Russia and the members of the complex are restricted to certain kinds of host trees. *B. repanda* (Fr.) Kuntze is a comparatively rare species that is found on *Sorbus pohuashanensis* (Hance) Hedl., and *S. sibirica* Hedl. in the Amur and Kamchatka regions as well as in Khabarovsk Territory. *B. pezizoides* (Ellis & Everh.) Kuntze prefers dead branches of *Ulmus* spp., but the species sometimes occurs on *Acer mono* Maxim. in the Primorsky Territory and the Amur region. Although the name *B. pezizoides* is reduced to a synonym of *B. repanda* (Ju et al. 1998), the two entities are hardly conspecific, and *B. pezizoides* can be easily distinguished by its coarsely papillate ostioles; it also has smaller stromata that are discoid and concave, while stromata of *B. repanda* are often irregularly flat. The substrate preferences of two species were already emphasized by Pouzar (1979), who called them the American and European ‘populations’ of *B. repanda* on *Ulmus* and *Sorbus*, respectively. Both species occur in eastern Asia but are restricted to their host plants, and *B. pezizoides* displays a ‘Grayan disjunction’ with respect its global distribution.

B. mandshurica occurs only on *Malus* spp. This species has small stromata as in *B. pezizoides*, but its ostioles are umbilicate, not coarsely papillate. The specimens from Russia on *Malus* spp. were identified as *B. repanda* (Ju et al. 1998), but they differ in the more narrow spores and the smooth surface of the relatively smaller stromata. Since *B. marginata* (Fr.) Pouzar is found on both *Malus baccata* and *Sorbus pohuashanensis*, this species has a host distribution that encompasses those of *B. mandshurica* and *B. repanda*. However, it is easily distinguished due to the widely ellipsoid or almost globose ascospores with curved germ slits.

2. *Chromendothia citrina* Lar.N. Vassiljeva,

Nizshie Rasteniya, Griby i Mokhoobraznye Dalnego Vostoka Rossii,
 Griby. Tom 4. Pirenomitsety i Lokuloaskomitsety (Sankt-Petersburg):
 172 (1998)

FIGS. 7–8

Stromata immersed, valloid, erumpent through the bark with bright-yellow, pulvinate ectostromatic disc $2-4 \times 1.5-2$ mm, studded with greenish or olivaceous ostioles at the surface becoming dark in age; perithecia polystichous, $300-400$ μm diam. Asci paraphysate, cylindrical, p. sp. $40-45 \times 4-5$ μm , stalks up to 40 μm long, apical ring chitinous. Ascospores uniseriate, one-celled, ellipsoid, brownish, $5-7 \times 3-3.5$ μm .

SPECIMENS EXAMINED: CHINA. Heilongjiang Province: Hulin, 854 State Farm, dead branches of *Quercus mongolica* Fisch. ex Turcz., 2.IX.2003, VLA P-1460. – RUSSIA. Primorsky Territory: Khasan region, Ryazanovka vicinity, dead branches of *Q. dentata* Thunb., 10.VIII.1991 (HOLOTYPE); Vladivostok vicinity, dead branch of *Q. mongolica*, 3.VI.2000, BPI 747935.

COMMENTS—The description given above is so similar to that of *Camarops lutea* (Alb. & Schwein.) Shear that the manuscript presenting *Chromendothia citrina* as a new species was initially rejected. This only indicates just how imperfect our knowledge is of the extensive parallelism of features that exists in different groups of pyrenomycetes. Since the genus *Camarops* was considered to be heterogeneous all the same (Vasilyeva 1988, 1994) and since *C. lutea* seemed to be surely not congeneric with its type-species *C. polysperma* (Mont.) J.H. Mill., the combination *Chromendothia lutea* (Alb. & Schwein.) Lar.N. Vassiljeva was suggested (Vasilyeva 1993). However that decision turned out to be wrong, as indicated by the results of further investigations.

The fungal complex '*Camarops* s.l.' is very similar to the situation that exists for diatrypaceous fungi in their development within tissues of hardwoods, their subsequent eruption, as well as the hard consistency of their stromata. In contrast, the genus *Chromendothia*, represented by its type-species *C. appendiculata* Lar.N. Vassiljeva and *C. citrina*, is characterized by soft and brightly colored stromata of the same consistency that is shared by hypocreaceous fungi and some diaporthalean members (*Endothia*, *Cryphonectria*) that were segregated into the family *Cryphonectriaceae* recently (Gryzenhout et al. 2006).

Although *Chromendothia* was placed near *Endothia* and *Cryphonectria* (*Hypocreales*: *Hypocreaceae*: *Endothieae*) previously (Vasilyeva 1998), this arrangement does not seem appropriate today, since both hypocreaceous and cryphonectriaceous pyrenomycetes have paraphysate asci. Species of *Chromendothia* possess paraphysate asci in fascicles, as do, for example, the type-species of *Mollicamarops* (Vasilyeva 2007). These genera comprise a group that does not fit into any family and order of pyrenomycetous fungi.

In view of the fascinating parallelism of features in different orders, we may venture to suggest that the whole array of orders including members with soft and brightly colored stromata represents another example that needs to be examined. The *Hypocreales* in this array might be considered as parallel to the *Xylariales* (cf. stromata of *Hypocrea* and *Hypoxyton*, *Nectria* and *Rosellinia*, *Podostroma* and *Xylaria* within two orders, respectively). The family *Cryphonectriaceae* might deserve being placed in its own order, which is parallel to the *Diaporthales*, whereas *Chromendothia* and *Mollicamarops* might be assigned to the order that is parallel to the *Diatrypales* (or *Boliniales*).

3. *Cryptosphaeria exornata* Lar.N. Vassiljeva,

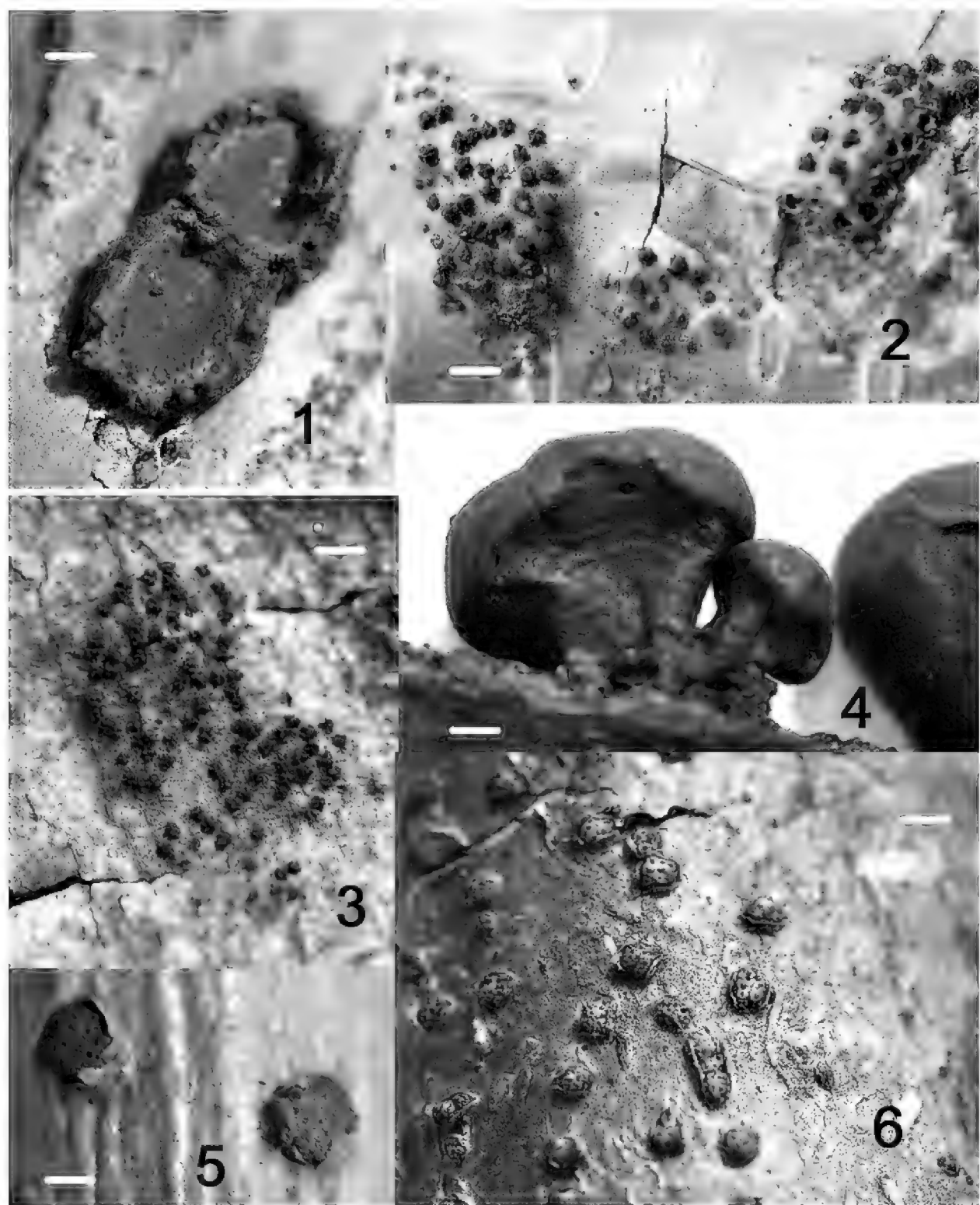
Nizshie Rasteniya, Griby i Mokhoobraznye Dalnego Vostoka Rossii,
Griby. Tom 4. Pirenomitsety i Lokuloaskomitsety (Sankt-Petersburg):
115 (1998)

FIG. 3

Stromata immersed in the bark remaining unchanged or becoming inflated and darkened, widely effused or spot-shaped, recognized by the crowded but separately emerging tops of perithecial beaks (ostioles) which are rather prominent, up to 500 µm diam., black and divided in a cross-shaped manner; perithecia scattered or aggregated, 350–500 µm diam. Asci cylindrical, paraphysate, 90–100 × 10–12 µm. Ascospores one-celled, allantoid, brownish, 22–24 × 3.5–4 µm.

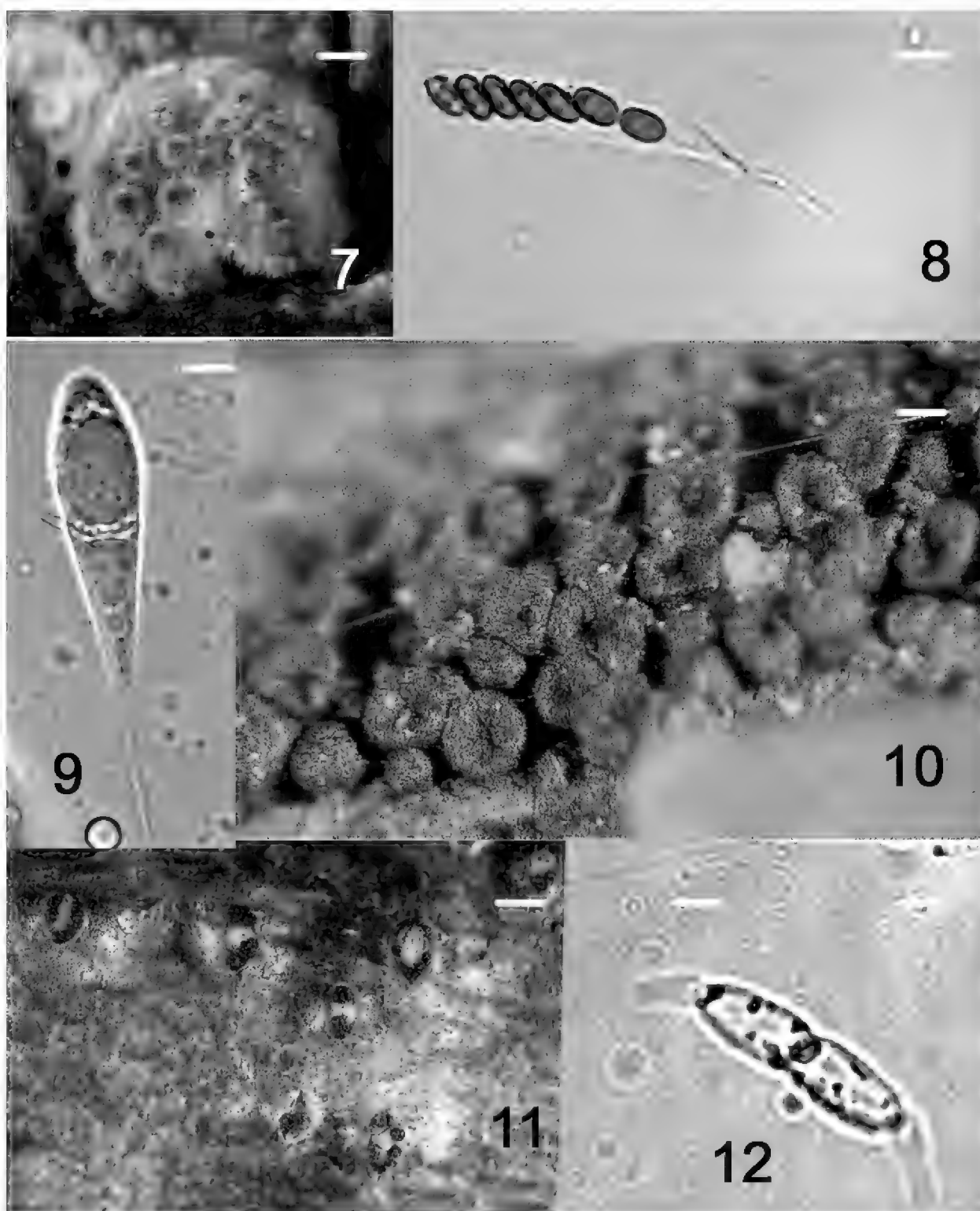
SPECIMENS EXAMINED: CHINA. Heilongjiang Province: Hulin: Dongfanghong, dead branches of *Fraxinus* sp., 3.IX.2003, VLA P-1477; Jilin Province: Changbai Mountain, dead branch of *Fraxinus* sp., 4.VIII.2008, VLA P-2177. – RUSSIA. Primorsky Territory: Sikhote-Alinsky Nature Reserve, dead branches of *Fraxinus* sp., 6.IX.1985, VLA P-304; Lazovsky Nature Reserve, dead branches of *Fraxinus* sp., 25.VII.1986, VLA P-294; Kedrovaya Pad Biosphere Reserve, dead branches of *Fraxinus* sp., 16.X.1987, VLA P-303; Ussuriysk Nature Reserve, dead branches of *Fraxinus* sp., 23.VIII.1989 (HOLOTYPE); Khanka Nature Reserve, dead branches of *F. mandshurica* Rupr., 21.VI.2003, VLA P-289; Khabarovsk Territory: Big Khekhtsir Nature Reserve, *F. mandshurica*, 24.VIII.1983, VLA P-290; Komsomolsky Nature Reserve, *Fraxinus* sp., 1.VII.1986, VLA P-291; Amur Region: Khingansky Nature Reserve, *F. mandshurica*, 30.VIII.1992, VLA P-288.

COMMENTS—This species is similar to *Cryptosphaeria eunomia* var. *fraxini* (Richon) Rappaz in having rather large ascospores, but these are never septate as is the case for that taxon. In addition, another feature distinguishing *C. exornata* is the character of the ostioles, which are conical, prominent and deeply sulcate. Nitschke (1867) described ostioles of *C. eunomia* (Fr.) Fuckel as very small ('minutissimo, punctiformi') and non-sulcate ('hemispherico'). Höhnelt (1923) wrote that *C. eunomioides* (G.H. Otth) Höhn. (= *C. eunomia* var. *fraxini*) had ostioles that were even less furrowed than those of *C. eunomia*, and



FIGS. 1—Stromata of *Biscogniauxia mandshurica*. 2—Stellate ostioles of *Cryptosphaeria venusta* on the bark surface. 3—Stellate ostioles of *Cryptosphaeria exornata* on the bark surface. 4—Stromata of *Daldinia gelatinoides*. 5—Stromata of *Diatrype macounii*. 6—Stromata of *Melogramma corylina*.
Scale bars: 1 = 2 mm, 2,3,5,6 = 1 mm, 4 = 3 mm (Nikon D40x and DG macro-objective SIGMA EX 105 mm F2.8).

one can conclude that ostioles in both varieties of *C. eunomia* can be slightly wrinkled (cf. also Rappaz 1987), but the latter condition is far removed from the large and strongly divided ostioles of *C. exornata*. The difference in ostiole size



FIGS. 7–8. *Chromendothia citrina*: 7—stroma, 8—ascus with ascospores. 9–10. *Loranitschkia viticola*: 9—ascospore, 10—ascomata. 11–12. *Melanconis marginalis*: 11—ostioles at the bark surface, 12—ascospore.

Scale bars: 7 = 0.6 mm, 10, 11 = 0.2 mm (digital camera Leica DFC300FX and microscope Leica MZ75), 8, 9 = 6 μ m, 12 = 5 μ m (Leica DFC300FX and microscope Leica DM 4500B).

was used by Rappaz (1987) for species delimitation in the family *Diatrypaceae*, and logic demands the separation of *C. exornata* and *C. eunomia* var. *fraxini* on this same basis.

4. *Cryptosphaeria venusta* Lar.N. Vassiljeva,
Nova Hedwigia, 43: 374 (1986)

FIG. 2

Stromata immersed in the bark becoming slightly inflated, delimited by a black zone in the substrate, usually spot-shaped, recognized by the crowded but separately emerging tops of perithecial beaks ('ostioles') which are rather prominent, black and divided in a cross-shaped manner; perithecia scattered or aggregated, 350–500 µm diam. Asci cylindrical, paraphysate, p. sp. 35–45 × 6–7 µm, with stalks up to 50 µm long. Ascospores one-celled, allantoid, hyaline, 7–10 × 1.5–2 µm.

SPECIMENS EXAMINED: CHINA. Jilin Province: Changbai Mountain, Dayangcha, dead branch of *Betula* sp., 4.VIII.2008, VLA P-2174. – JAPAN. Tochigi Prefecture: Ashio, dead branches of *Betula* sp., 28.VI.1999, VLA P-1480. – RUSSIA. Primorsky Territory: Sikhote-Alinsky Nature Reserve, dead branches of *B. platyphylla* Sukaczew, 12.VIII.1985, VLA P-309; Lazovsky Nature Reserve, dead branches of *B. platyphylla*, 29.VII.1986, VLA P-310; Kedrovaya Pad Biosphere Reserve, dead branches of *Betula* sp., 17.X.1987, VLA P-307; Ussuriysk Nature Reserve, dead branches of *Betula* sp., 13.VIII.1989, VLA P-312; Khabarovsk Territory: Big Khekhtsir Nature Reserve, dead branches of *Betula* sp., 28.VIII.1983 (HOLOTYPE); Amur Region: Khingansky Nature Reserve, dead branches of *Betula* sp., 25.VIII.1992, VLA P-311; Kurile Isles: Kunashir Island, dead branches of *Betula* sp., 16.VIII.1987, VLA P-316.

COMMENTS—The record for Japan listed herein is also the first one for that country. It was found there in a rather high elevation *Betula* forest in a mountainous region (Ashio). This beautiful species is rather common, and it is surprising that it was not described long ago.

5. *Daldinia gelatinoides* Lar.N. Vassiljeva,

Nizshie Rasteniya, Griby i Mokhoobraznye Dalnego Vostoka Rossii,
Griby. Tom 4. Pirenomitsety i Lokuloaskomitsety (Sankt-Petersburg):
177 (1998)

FIG. 4

Stromata turbinate, usually sessile, solitary or in groups, smooth or wrinkled, 1–3.5 × 0.5–3 cm, filled with viscous liquid when fresh, after drying hollow inside; surface brown vinaceous, ostioles inconspicuous, KOH-extractable pigments violet; perithecia tubular, 1–1.3 × 0.3–0.5 mm. Asci p. sp. 80–110 × 7–8 µm, stipe 50–70 µm long, with amyloid ring 3 × 0.5–0.7 µm. Ascospores ellipsoid-equilateral with broadly rounded ends, brown, (9–)12–14(–16) × 6–8 µm, with straight germ slit spore-length.

SPECIMEN EXAMINED: CHINA. Heilogjiang Province: Sanjiang Nature Reserve, Dongxing Cun, logs, 5.VIII.2004, VLA P-1786. – RUSSIA. Ussuriysk Nature Reserve, dead branches of *Carpinus cordata* Blume, 10.VIII.1989 (HOLOTYPE); Vladivostok city, living tree of *Fraxinus* sp., 12.IX.1996, VLA P-1785; Vladivostok vicinity, Sirenevka, dead trunk of *Kalopanax septemlobus* (Thunb.) Koidz. and living tree of *Quercus mongolica*, 26.IX.1999, VLA P-1788 & P-1974.

COMMENTS—This species display a tendency to parasitize living deciduous trees, but it appears to display no special preference for particular types of trees as in the case for seemingly saprotrophic species *Daldinia singularis* Y.M. Ju et al. and *D. carpinicola* Lar.N. Vassiljeva & M. Stadler (both on *Carpinus cordata* in eastern Russia) or *D. loculata* (Lév.) Sacc. (on *Betula* spp.).

6. *Diatrype macounii* Ellis & Everh.,

Proc. Acad. Nat. Sci. Phila. 1890: 224 (1890)

FIG. 5

Stromata discrete, scattered, flat, disc-shaped, circular or oval in outline, usually 1–1.8 mm diam., erumpent by tearing of periderm into sepaloid scraps, with dark brown ectostromatic disc, inside white above perithecia and brownish below, delimited by a black zone in the substrate; perithecia at several levels in stromata, 300–400 µm diam., opening through black, indistinctly sulcate ostioles. Asci clavate, p.sp. 25–30 × 3–4 µm, stipes up to 40–50 µm long. Ascospores allantoid, yellowish, 4–6 × 0.7–1 µm.

SPECIMEN EXAMINED: CHINA. Heilongjiang Province: Hulin, Dongfanghong, dead branches of *Salix* sp., 3.IX.2003, VLA P-1503.

COMMENTS—The first record of this species for China is also the first for all of East Asia, even Eurasia. It was described from the Agassiz in British Columbia (Fraser Valley), supposedly on *Acer rubrum* L., but the substrate was later recognized as *Salix* sp. (Rappaz 1987). The name of this species was reduced to a synonym of *Diatrype bullata* (Hoffm.) Fr. (Glawe & Rogers 1984, Rappaz 1987, Vasilyeva 1998), but *D. macounii* was described with ascospores 4–6 µm long (cf. Ellis & Everhart 1892) whereas typical specimens of *D. bullata* have ascospores 6–10 µm long (Nitschke 1867, Saccardo 1882, Winter 1887). A range in ascospore length of 4–6 µm distinguishes many diatrypaceous fungi such as *D. hypoxylodes* De Not., *Diatrypella decorata* Nitschke, *Eutypa limiformis* (Schwein.) Berk. and other examples. The appearance of stromata in *Diatrype macounii* suggests at once an entity that is different from *D. bullata*, since the stromata are rather small and discoid in comparison with the larger and shield-shaped ones of the latter species, which often have a sinuous, undulate outline.

In contrast to many species having a ‘Grayan disjunction’ in their global distribution, *D. macounii* seems to have a northern-amphipacific or ‘Bering disjunction’ as do *Biscogniauxia bartholomaei* (Peck) Lar.N. Vassiljeva, *Hypoxylon alnicola* (see below), *Nectria pithoides* Ellis et Everh. and certain other species of pyrenomycetous fungi.

7. *Loranitschkia viticola* Lar.N. Vassiljeva,

Mikologiya i Fitopatologiya 24: 207 (1990)

FIG. 9–10

Ascomata 260–320 µm diam., superficial on scanty subiculum or simply on the substrate, gregarious or scattered, pear-shaped, collapsing to become cupulate,

non-ostiolate, black, without hairs or bristles. Asci clavate, paraphysate, on short stalks, $90\text{--}110 \times 20\text{--}24\ \mu\text{m}$. Ascospores biserial, hyaline, clavate, with a septum below the middle, $25\text{--}33 \times 10\text{--}12\ \mu\text{m}$, rounded at the apex, attenuated below in a tail-like appendage $24\text{--}26\ \mu\text{m}$ long.

SPECIMEN EXAMINED: CHINA. Jilin Province: Changbai Mountain: Dayangcha, dead twigs of *Vitis amurensis* Rupr., 4.VIII.2008, VLA P-2172. – RUSSIA. Kurile Islands, Kunashir Island, dead twigs of *V. cognata* Pulliat ex Planch., 23.VIII.1987 (HOLOTYPE); Primorsky Territory: Ussuriysk Nature Reserve, dead twigs of *V. amurensis*, 27.VIII.1989, VLA P-235; District Shkotovo, Anisimovka vicinity, dead twigs of *V. amurensis*, 2.IX.1993, VLA P-2317; Jewish Autonomous Region: Bastak Nature Reserve, dead twigs of *V. amurensis*, 19.VIII.2004, VLA P-334.

8. *Melanconis marginalis* (Peck) Wehm.,

Papers Michig. Acad. Sci. Arts Lett., 6: 382 (1926)

FIG. 11–12

= *Diaporthe marginalis* Peck, Rep. New York State Mus., 39: 52 (1886)

= *Melanconis alni* var. *marginalis* (Peck) Wehm., Univ. Michig. Stud. Sci., 9: 27 (1941)

Stromata immersed, valloid, erumpent through the bark with whitish or creamy ectostromatic disc about 0.1–0.3 mm diam. that is surrounded or penetrated by a cluster of black protruding ostioles; perithecia circinate, 400–500 μm diam. Asci fusoid-clavate, sessile, $70\text{--}90 \times 15\text{--}20\ \mu\text{m}$. Ascospores irregularly biserial, fusoid-ellipsoid, two-celled, hyaline, constricted at the septum, ends rounded, $20\text{--}24 \times 5\text{--}6.5\ \mu\text{m}$, often with terminal elongated appendages up to 5–7 μm .

SPECIMENS EXAMINED: CHINA. Jilin Province: Changbai Mountain, dead branch of *Duschekia* sp. 3.VIII.2008, VLA P-2180. – RUSSIA. Amur region: Zeisky State Nature Reserve, dead branches of *D. fruticosa* (Rupr.) Pouzar, 3. VIII.1988, VLA P-1835; Magadan region: Bilibino district, Lake Nizhniy Ilirney, dead branches of *D. fruticosa*, 21.VIII.1980, VLA P-2305; Kamchatka region: Kronotsky National Biosphere Reserve, dead branches of *D. fruticosa*, 6.VIII.1981, VLA P-1834; Sakhalin region: Sakhalin Island, dead branches of *D. fruticosa*, 1.VIII.2000, VLA P-268.

COMMENTS—This species seems to prefer dead branches of *Duschekia* (= *Alnus* subgenus *Alnobetula*) to the same degree as does *Apioporthella bavarica* Petr., which was described from *D. alnobetula* (Ehrh.) Pouzar (Petrak 1929) and much later found in northern Russia on *D. fruticosa* (Vasilyeva 1987).

At present, all specimens of '*Melanconis alni* Tul.' found on dead branches of *Duschekia* in the northern part of eastern Russia (Vasilyeva 1998) should be assigned to *M. marginalis*. Some Japanese collections of this species (Kobayashi 1970) are also reported from host plants belonging in the genus *Duschekia*, namely *D. maximowiczii* (Callier) Pouzar [= *Alnus crispa* subsp. *maximowiczii* (Callier) Hultén].

Peck (1886) described *Diaporthe marginalis* on dead branches of *Alnus viridis* (Chaix) DC. (also known as *Duschekia alnobetula*). The type specimen of Peck's species was collected in eastern North America (New York: Elizabeth town). Wehmeyer (1941) listed this species as *Melanconis alni* var. *marginalis*

and noted as host plants not only members of *Alnus* subgenus *Alnobetula* [*Alnus crispa* (Aiton) Pursh, *A. mollis* Fernald, *A. viridis*], but also *A. tenuifolia* Nutt. (subgenus *Alnus*) and even *Corylus rostrata* Aiton (albeit with questionable identification). His list of localities included not only the eastern portion of the United States of America (Michigan, New Hampshire, New York) and eastern provinces of Canada (Ontario, Nova Scotia) but also the western state of Idaho.

Jansen (1984) indicated *Melanconis marginalis* as occurring on *Alnus tenuifolia* in Idaho and concluded that “there appear to be at least three groups in *M. marginalis*, one from eastern North America and two from Idaho” (Jansen 1984: 279). Some specimens from Idaho have ascospores up to 30 µm, which would be exceptionally long for *M. marginalis*. Others (‘normal-spored’) probably could be assigned to *M. alni*. The conjecture can be made that only specimens of *M. marginalis* from eastern North America on *Duschekia* represent that species on both biogeographical and ecological grounds.

Biogeographically, *Melanconis marginalis* could be considered as having a ‘Grayan disjunction’ in its global distribution, being restricted to northeastern Asia and the region around the Great Lakes (Michigan, Minnesota, New York, Ontario) as well as some adjacent areas of North America. It is exactly this region that is the most promising with respect to expectations of finding those species that also occur in eastern Russia, Japan, north-eastern China and on the Korean Peninsula. For example, *Diaporthella platasca* (Peck) Wehm., known previously from the state of New York (Wehmeyer 1933) was found recently in eastern Russia (Sakhalin Island), and this species is not conspecific with *D. aristata* (Fr.) Petr. (cf. Barr 1978).

Ecologically, some closely related species of pyrenomycetous fungi seem to replace each other on related host plants and display a peculiar vicarious pattern of distribution. As such, *Alnus hirsuta* (Spach) Turcz. ex Rupr. in the Russian Far East never supports *Melanconis marginalis*; instead, *M. thelebola* (Fr.) Sacc. is often found on dead branches of that host plant. Another example of closely related and ecologically vicarious species on *Alnus* and *Duschekia* in the Russian Far East is represented by *Hypoxyton multifforme* (Fr.) Fr. and *H. alnicola* Lar. N. Vassiljeva (= *H. multifforme* var. *alaskense* Y.M. Ju & J.D. Rogers). The latter species has a restricted distribution on *Duschekia fruticosa* (Vasilyeva 1998) at high latitudes in east northern Asia (Kurile Isles, Magadan and Kamchatka regions of Russia) and is also reported on *Alnus sitchensis* (Regel) Sarg. [= *A. viridis* = *Duschekia alnobetula*] in Alaska (Ju & Rogers 1996). Consequently, the distribution of *Hypoxyton alnicola* extends across what has been referred to as Beringia (the land mass that once connected Alaska and the Russian Far East), whereas the true *H. multifforme* occurs on *Alnus hirsuta* and *Betula* spp. of eastern Russia.

9. *Melogramma corylina* Lar.N. Vassiljeva,

Nizshie Rasteniya, Griby i Mokhoobraznye Dalnego Vostoka Rossii,
Griby. Tom 4. Pirenomitsety i Lokuloaskomitsety (Sankt-Petersburg):
94 (1998)

FIG. 6

Stromata small, truncate, erumpent by cream-brownish ectostromatic disc 0.5–1.5 mm diam., studded with dark ostioles, with reddish tissue inside, without stromatic zone in the substrate. Perithecia in the upper part of stromata, 150–200 µm diam. Asci cylindrical-clavate, sessile, 60–70 × 12–15 µm, J-negative, no visible apical ring. Ascospores overlapping parallel to each other, cylindrical, with conical ends, often slightly curved, greenish or brownish, 3–5-septate, 46–56 × 5–5.5 µm.

SPECIMENS EXAMINED: CHINA. Heilongjiang province: Sanjiang Nature Reserve, Dongxing Cun, dead branch of *Corylus* sp., 5.VIII.2004, VLA P-1693. – RUSSIA. Amur region: Khingansky Nature Reserve, dead branches of *C. heterophylla* Fisch. ex Trautv., 8.VIII.1992 (HOLOTYPE).

COMMENTS—*Melogramma campylosporum* Fr. was reported to occur mainly on *Carpinus* spp. in Europe and eastern North America but was also supposed to be found rarely on *Corylus avellana* L. (Laflamme 1975). We have seen the stromata of *M. campylosporum* (as *M. vagans* De Not.) on *Corylus* sp. in the exsiccate collection (Tranzschel & Serebrianikow's Mycotheca Rossica N. 30). Asci and ascospores were not obtained because the material was old, but stromata, which are larger and more uneven, are surely different from those of *M. corylina* from northeastern Asia.

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Literature cited

- Barr ME. 1978. The *Diaporthales* of North America with emphasis on *Gnomonia* and its segregates. *Mycologia Memoir* 7: 1–232.
- Bau T. 2005. Higher taxa of *Ascomycota* in Jilin Province, China. *Journal of Fungal Research* 3: 1–6. (in Chinese)
- Dai YC, Bau T. 2007. *Hypocreopsis lichenoides* (Ascomycetes) new to China. *Journal of Fungal Research* 5: 63–65.
- Doi Y, Liu PG, Tamura M. 2001. A new species of the *Hypocreales* (Ascomycota) from Mt. Changbaishan, northeast China. *Bull. Nat. Sci. Mus., ser. B*, 27: 57–63.
- Ellis JB, Everhart BM. 1892. The North American Pyrenomycetes. Newfield, New Jersey. 793 p.

- Glawe DA, Rogers JD. 1984. *Diatrypaceae* in the Pacific Northwest. *Mycotaxon* 20: 401–460.
- Gryzenhout M, Myburg H, Wingfield BD, Wingfield MJ. 2006. *Cryphonectriaceae* (*Diaporthales*), a new family including *Cryphonectria*, *Chrysosporthe*, *Endothia* and allied genera. *Mycologia* 98: 239–249.
- Höhnelt F. 1923. Fragmente zur Mykologie. Nr. 1215–1225. Sitz. Akad. Wiss. Wien, Math. Nat. Kl., Abt. I, 132: 89–118.
- Jensen JD. 1984. *Melanconis marginalis* from northern Idaho. *Mycotaxon* 20: 275–281.
- Ju YM, Rogers JD. 1996. A revision of the genus *Hypoxylon*. *Mycologia Memoir* 20: 1–365.
- Ju YM, Rogers JD, San Martín F, Granmo A. 1998. The genus *Biscogniauxia*. *Mycotaxon* 66: 1–98.
- Ju YM, Vasilyeva L, Rogers JD. 1999. *Daldinia singularis* sp. nov. from eastern Russia and notes on some other taxa. *Mycotaxon* 71: 405–412.
- Ju YM, Hsieh HM, Vasilyeva LN, Akulov A. 2009. Three new *Xylaria* species from Russian Far East. *Mycologia* 101: 548–553.
- Kobayashi T. 1970. Taxonomic studies of Japanese *Diaporthaceae* with special reference to their life-histories. *Bull. Gov. Forest Exp. Station* 226: 1–242.
- Kobayashi T, Zhao JZ. 1989. Notes on diseases of woody plants and their causal fungi in Heilongjiang Province, China (1). *Trans. Mycol. Soc. Japan* 30: 277–293.
- Laflamme G. 1975. Les genres *Melogramma* Fries et *Melanamphora* gen. nov., Sphaeriales. *Sydowia* 28: 237–274.
- Lumbsch HT, Huhndorf SM. 2007. Outline of *Ascomycota* – 2007. *Myconet* 13: 1–58.
- Nitschke T. 1867. Pyrenomycetes Germanici. *Breslau* 1(1): 1–320.
- Peck CH. 1886. Plants not before reported. *New York State Mus. Rep.* 39: 38–53.
- Petrak F. 1929. Mykologische Notizen X. *Ann. Mycol.* 27: 324–410.
- Pouzar Z. 1979. Notes on taxonomy and nomenclature of *Nummularia* (Pyrenomycetes). *Ceská Mykol.* 33: 207–218.
- Rappaz F. 1987. Taxonomie et nomenclature des Diatrypaceae à asques octospores (1). *Mycologia Helvetica* 2: 285–648.
- Saccardo PA. 1882. *Sylloge Fungorum*. Vol. 1. Patavii. 766 p.
- Stadler M, Læssøe T, Vasilyeva L. 2005. The genus *Pyrenomyxa* and its affinities to other cleistocarpous *Hypoxyloideae* as inferred from morphological and chemical traits. *Mycologia* 97: 1129–1139.
- Teng SC. 1939. A contribution to our knowledge of the higher fungi of China. *Academia Sinica, Beijing*. 614 p.
- Vasilyeva LN. 1987. Pyrenomycetes and loculoascomycetes of the northern Far East. *Nauka, Leningrad*. 255 p. (in Russian).
- Vasilyeva LN. 1988. The taxonomic position of *Camarops polysperma* (Mont.) J.H. Miller and *Biscogniauxia* O. Kuntze in the Far East. *Mikologiya i Fitopatologiya* 22: 388–396 (in Russian).
- Vasilyeva LN. 1993. *Chromendothia* – a new genus of the family *Hypocreaceae*. *Mikologiya i Fitopatologiya* 27: 1–7 (in Russian).
- Vasilyeva LN. 1994. The system of pyrenomycetes. *Dal'nauka, Vladivostok*. 424 p. (in Russian).
- Vasilyeva LN. 1998. Pyrenomycetes and loculoascomycetes. In: *Lower plants, fungi, and bryophytes of the Russian Far East*. Vol. IV (ed. Azbukina ZM). *Nauka, Saint-Petersburg* 419 p. (in Russian).
- Vasilyeva L. 2001. Pyrenomycetes of the Russian Far East – Additions and corrections. 1. *Rossmania ukurunduensis* gen. et sp. nov. *Mycoscience* 42: 399–401.
- Vasilyeva LN. 2007. Pyrenomycetes of the Russian Far East 2. *Mollicamarops stellata* gen. et sp. nov. *Mycotaxon* 99: 159–162.

- Vasilyeva LN, Rossman AY, Farr DF. 2007 New species of the *Diaporthales* from eastern Asia and eastern North America. *Mycologia* 99: 852–859.
- Vasilyeva L, Stadler M. 2008. Pyrenomycetes of the Russian Far East 3. Three new *Daldinia* species (*Xylariaceae*). *Mycotaxon* 104: 287–296.
- Vasilyeva LN, Stephenson SL. 2007. *Cryptovalsaria* gen. nov. and its two new species from eastern Asia and south central North America. *Sydowia* 59: 154–160.
- Wehmeyer LE. 1933. The genus *Diaporthe* Nitschke and its segregates. *Univ. Michig. Stud. Sci.* 9: 1–349.
- Wehmeyer LE. 1941 A revision of *Melanconis*, *Pseudovalsa*, *Prosthecius* and *Titania*. *Univ. Michig. Stud. Sci.* 14: 1–161.
- Winter G. 1887. Pilze: Ascomyceten. Rabenhorsts's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz, 2. Aufl., 1(2). Leipzig.

Rediscovery of *Trogia cyanea* and a record of *T. infundibuliformis* (Marasmiaceae, Agaricales) from Kerala State, India

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Abstract — *Trogia cyanea* is rediscovered from Kerala State, India, more than seven decades after its original discovery from Malaysia and *Trogia infundibuliformis* is recorded for the first time from Kerala. Both species are fully described and illustrated.

Key words — *Basidiomycota*, floristics, taxonomy

Introduction

The genus *Trogia* Fr. (Marasmiaceae, Agaricales, Basidiomycota) includes species with clitocyboid to omphalinoid basidiomata that are somewhat tough and readily restored when remoistened after drying. Corner (1966) employed a broad genus concept and accepted 56 species accommodating species from many closely related genera with a sarcodimitic tramal construction characterized by presence of long-celled, inflated generative hyphae bound together by intertwining slender, frequently septate, generative hyphae. Singer (1986) strongly opposed such a broad definition and accepted only three species. Singer considered the easily reviving basidiomata, the narrow and often furcated lamellae, the interwoven hyphae of lamellar trama and the characteristically pigmented trichodermial epicutis as the major distinctive features separating *Trogia* from close allies like *Clitocybe* (Fr.) Staude, *Gerronema* Singer, and *Neoclitocybe* Singer. While investigating the taxonomic value of sarcodimitic tissues in agarics, Redhead (1987) observed such tissues in several agaric genera. Instead of transferring them to a single genus, Redhead (1987) adopted the *Xerulaceae*, which he characterized by presence of sarcodimitic tissues. Corner (1991) defended his concept of *Trogia*. Unfortunately, the type species of *Trogia*, *T. montagnei* Fr. from India, has not been studied properly and its type specimen remains untraceable (Corner 1991, Wilson &

Desjardin 2005). Owing to this reason, the taxonomic boundaries of *Trogia* remain unknown. In their phylogenetic analyses, Wilson & Desjardin (2005) found *T. infundibuliformis*, a species phenetically similar to the protologue of *T. montagnei*, to form a sister group of marasmioid clade on a long branch. As far as we know, *T. infundibuliformis* is the only species of the genus treated in any molecular phylogenetic study and there is an urgent need for a comprehensive molecular phylogenetic study of the group.

Members of this predominantly tropical genus are strict saprobes encountered on dead wood and other plant debris on the forest floor. Manjula (1983) listed *T. montagnei* as the only acceptable record from India and Natarajan et al. (2005) listed *T. subviridis* Corner, *T. lilaceogrisea* Corner, and *T. infundibuliformis* as other Indian records of the genus. During our investigations on the agarics of Kerala, two species of *Trogia* were collected and examined. These collections are described and discussed below.

Materials and methods

Conventional morphology-based taxonomic methods were employed for this study. Microscopic observations were made on material stained with 1% aqueous solutions of phloxine and Congo red and mounted in 3% aqueous KOH. Melzer's reagent, cresyl blue, and cotton blue were used to observe whether the spores were dextrinoid, metachromatic, and cyanophilic respectively. Twenty basidiospores per specimen were measured. Colour codes refer to Kornerup & Wanscher (1978). All examined collections cited are deposited at Kew Herbarium and these collections are indicated by their Kew (Mycology) accession numbers (e.g., K(M)146176).

Taxonomic account

Trogia cyanea Corner, Monogr. Cantherelloid Fungi: 205. 1966. FIGURES 1A, 2A–E
BASIDIOMATA omphalinoid, rather small, somewhat tough and leathery, distinctly reviviscent, lignicolous. PILEUS 17–30 mm diam., initially applanate with a distinctly depressed centre, later almost infundibuliform; surface dark blue (21F4, 21F3), hygrophanous and turning slightly paler, finely but distinctly striate from margin to half way towards the disc, finely pubescent under a lens, dry; margin inrolled when very young and finally becoming straight, initially entire, becoming somewhat eroded. LAMELLAE decurrent, moderately crowded, with lamellulae in three to four tiers, sometimes furcate, up to 1 mm thick, dark blue (21F4, 21F3); edge finely fimbriate, with fine grey dots. CONTEXT less than 1 mm thick, dark blue (21F4, 21F3). STIPE 18–30 × 1–2 mm, central, terete, solid, with a slightly discoid base surrounded by radiating mycelium;

surface concolorous with the pileus and lamellae, rather velutinous under a lens. ODOUR and taste not distinctive. SPORE-PRINT white.

SPORES $6\text{--}9 \times 4\text{--}6 \mu\text{m}$, amygdaliform in face view, ellipsoid in profile, thin-walled, smooth, with refractive guttules, inamyloid, non-cyanophilic, non-metachromatic in cresyl blue. BASIDIA $21\text{--}34 \times 7\text{--}10 \mu\text{m}$, cylindrico-clavate, thin-walled, hyaline, with guttulate contents, 4-spored; sterigmata up to $5 \mu\text{m}$ long. LAMELLA-EDGE sterile with crowded cheilocystidia. CHEILOCYSTIDIA $20\text{--}63 \times 6\text{--}9 \mu\text{m}$, sinuoso-cylindric with an obtusely rounded apex, with a rather thick (up to $1 \mu\text{m}$) greyish to dark greyish wall. PLEUROCYSTIDIA absent. LAMELLAR TRAMA irregular with somewhat loosely interwoven hyphae; hyphae $2\text{--}22 \mu\text{m}$ wide, hyaline, thin- to slightly thick-walled, often showing inflated, fusoid elements. PILEAL TRAMA interwoven; hyphae $2\text{--}21 \mu\text{m}$ wide, hyaline, thin- to slightly thick-walled, often with inflated fusoid elements. PILEIPELLIS a cutis; hyphae $2\text{--}5 \mu\text{m}$ wide, not inflated, thin-walled, with greyish to dark greyish, plasmatic and encrusting pigments. PILEOCYSTIDIA frequent, arising as erect lateral branches of cutis hyphae, $15\text{--}24 \times 5\text{--}7 \mu\text{m}$, short clavate with rounded apex, thin-walled, hyaline. STIPITPELLIS a cutis; hyphae $2\text{--}6.7 \mu\text{m}$ wide, thin-walled, with a pale grey plasmatic pigment. CAULOCYSTIDIA numerous, scattered or in clusters, arising as lateral branches of cutis hyphae, $40\text{--}65 \times 5\text{--}7 \mu\text{m}$, versiform but mostly flexuous, thin- to thick-walled. STIPE TRAMA composed of thick-walled ($0.5\text{--}2 \mu\text{m}$ thick), mostly uninflated hyphae ($2\text{--}7 \mu\text{m}$ wide) with some long and inflated (up to $20 \mu\text{m}$) fusoid elements. Clamp connections frequent in lamellar, pileal and stipe trama.

HABITAT: On decaying twigs and wood on forest floor, scattered or in small groups, locally abundant.

COLLECTIONS EXAMINED — INDIA, KERALA STATE, Calicut District, KOYILANDI: 27 Oct. 2004, T.K. Arun Kumar AK155 (K(M): 146176); 3 Nov. 2004, T. K. Arun Kumar AK165 (K(M): 146175); PERUVANNAMUZH: 13 Nov. 2004, T.K. Arun Kumar AK198 (K(M): 146173); Koyilandi: 20 Nov. 2004, T.K. Arun Kumar AK155a (K(M): 146172); Wayanad District, KOTTATHARA: 21 Nov. 2004, T.K. Arun Kumar AK204 (K(M): 146174); MALAYSIA, MALAYA, PAHANG: 26 May 1931, E.J.H. Corner (K(M): 143823, HOLOTYPE).

DISCUSSION: Easily reviving dark blue basidiomata, strongly hygrophanous pileal surface, discoid stipe base with radiating basal mycelium, and thick-walled, sinuoso-cylindric cheilocystidia are diagnostic of this species. Except for the size of the basidia, Corner's (1966, 1991) description of *T. cyanea* fits our collections perfectly. An examination of the type material of *T. cyanea* confirmed that our collections are conspecific with Corner's species. Remarkably, the Kerala collections seem to be the first report of the species after its original description, and outside the type locality. The type material of *T. cyanea* was collected by Corner from Malaysia in 1931.

Although Corner's broad concept of *Trogia* is highly disputed, accommodation of this species in that genus seems acceptable even under the restricted concept of the genus followed by Singer (1986) as it has almost all the distinguishing characters that Singer listed for *Trogia*. A combination of characters — darkly pigmented, easily reviving carpophores, narrow, coloured and often forked lamellae, and the socle-like stipe-base — excludes genera like *Clitocybe*, *Gerronema* and *Neoclitocybe*.

Other blue-green species of the genus, such as *Trogia pleurotoides* Corner and *T. stereoides* Corner, differ from *T. cyanea* in their habit and in some microscopic features. *Trogia pleurotoides* is laterally to eccentrically stipitate with an almost flabelliform fruit body and has minutely ornamented spores. A pleurotoid fruit body, a sarcotrimitic trama, and absence of lamellae and cystidia are the main characters that keep *T. stereoides* apart. *Trogia subviridis*, another blue-green species, differs from *T. cyanea* in having white to yellowish stipe and lamellae, pleurocystidia, and compactly arranged clavate or ventricose pileal elements. *Trogia calyculus* Corner is a very closely related species that can be separated from *T. cyanea* based on its relatively minute basidiomata, clavate to ventricose cheilocystidia, rarely with apical prolongations, and occasional pleurocystidia.

Trogia infundibuliformis Berk. & Broome, J. Linn. Soc., Bot. 14: 45. 1873

FIGURES 1 B; 2 F–J

BASIDIOMATA small to somewhat medium-sized, omphalinoid, tough and leathery, distinctly reviviscent, lignicolous. **PILEUS** 15–52 mm diam., infundibuliform, often splitting radially from the margin to the centre into segments with age; surface dull white to brown (7E4) when young, becoming yellowish white (1A2), greyish orange (6B3), or light brown (6D5), mostly with a lilaceous tinge, darker at the striations on maturity, darkening on drying, initially slightly translucent-striate, distinctly sulcate-striate on maturity, almost glabrous to the naked eye but finely pubescent under a lens, dry; margin incurved when very young, becoming straight, initially entire, becoming irregular or at times lobate, finally fissile. **LAMELLAE** decurrent, distant to subclose, with lamellulae in one or two tiers, rarely furcate, up to 1 mm broad, concolorous with the pileus; edge grooved and finely fimbriate with fine grey dots when observed under a lens. **CONTEXT** less than 1 mm thick, yellowish white (1A2), greyish orange (6B3) or light brown (6D5). **STIPE** 12–23 × 1.5–4 mm, central to eccentric, fibrous, slightly compressed or terete, solid, arising from a discoid base with radiating basal mycelium; surface concolorous with the pileus and lamellae or darker, finely velutinous under a lens. **ODOUR** and taste not distinctive. **SPORE-PRINT** white.



FIGURE 1. A, *Trogia cyanea*; B, *Trogia infundibuliformis*

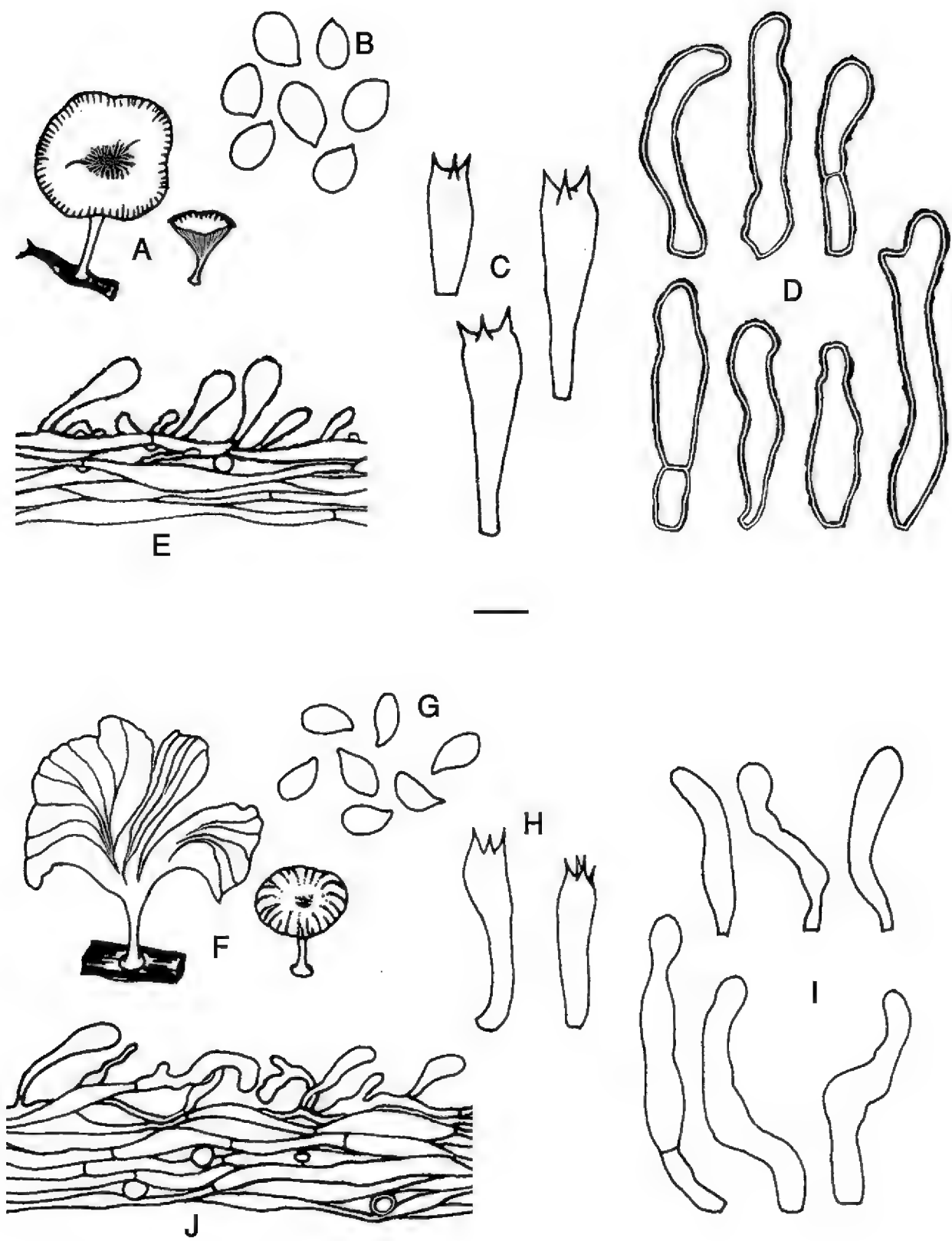


FIGURE 2. A–E *Trogia cyanea*:
A, basidiomata; B, basidiospores; C, basidia; D, cheilocystidia; E, pileipellis;
2. F–J *Trogia infundibuliformis*:
F, basidiomata; G, basidiospores; H, basidia; I, cheilocystidia; J, pileipellis.
Scale bar = 10 μ m for microscopical structures and 10 mm for basidiomata.

SPORES $7\text{--}10 \times 4\text{--}5 \mu\text{m}$, mostly oblong-ellipsoid, some ellipsoid and a few amygdaliform, thin-walled, smooth, with large refractive guttules, inamyloid, non-cyanophilic, non-metachromatic in cresyl blue. BASIDIA $29\text{--}50 \times 4\text{--}7 \mu\text{m}$, narrow, elongate clavate, thin-walled, hyaline, with guttulate contents, with prominent basal clamp-connections, 4-spored; sterigmata up to $5 \mu\text{m}$ long. LAMELLA-EDGE sterile with abundant cheilocystidia. CHEILOCYSTIDIA $20\text{--}61 \times 5\text{--}8 \mu\text{m}$, cylindric, flexuous, strangulated or almost moniliform, with obtusely rounded apices, thin- to slightly or irregularly thick-walled (up to $1 \mu\text{m}$), hyaline to pale grey. PLEUROCYSTIDIA absent. LAMELLAR TRAMA highly irregular; hyphae $2\text{--}15 \mu\text{m}$ wide, hyaline, thin- to thick-walled (up to $1 \mu\text{m}$), often showing inflated, fusoid elements. PILEAL TRAMA interwoven; composed of $2\text{--}13 \mu\text{m}$ wide, hyaline, thick-walled (up to $1.5 \mu\text{m}$), inamyloid hyphae often with inflated fusoid elements. PILEIPELLIS a cutis of $2\text{--}6 \mu\text{m}$ wide, non-inflated, thin- to thick-walled, hyaline to pale grey plasmatic pigmented hyphae producing short, thin-walled, highly branched or nodulose outgrowths and occasionally disrupted with erect, $28\text{--}41 \times 4\text{--}6.5 \mu\text{m}$ large cystidioid end-cells. STIPITPELLIS a cutis; hyphae $2\text{--}8 \mu\text{m}$ wide, slightly thick- to thick-walled ($0.5\text{--}1 \mu\text{m}$), hyaline or pale brown. CAULOCYSTIDIA $31\text{--}52 \times 5\text{--}7 \mu\text{m}$, numerous, in clusters, similar to cheilocystidia in shape, thin- to thick-walled. STIPE TRAMA made up of thick-walled (up to $2 \mu\text{m}$), mostly uninflated hyphae ($2\text{--}10 \mu\text{m}$ wide) with some long and inflated (up to $15 \mu\text{m}$) fusoid elements. All hyphae with abundant clamp connections.

HABITAT: On decaying twigs on forest floor, scattered or in groups.

COLLECTIONS EXAMINED — INDIA, KERALA STATE, Calicut District, THUSHARAGIRI: 22 July 2004, T.K. Arun Kumar AK73 (K(M): 146178); PERUVANNAMUZHI: 13 Nov. 2004, T.K. Arun Kumar AK192 (K(M): 146179); 5 July 2006, T.K. Arun Kumar AK411 (K(M) 146177).

DISCUSSION: *Trogia infundibuliformis* is a frequently encountered wild agaric, readily recognized by its tough basidiomata that split radially in maturity. Basidiomata of almost the same age, even from close localities, show a wide colour range (from dull white to brown) and are slightly translucent striate. Fruit bodies arise from distinct discoidal bases. Except for their abundant cheilocystidia, the Kerala collections have characters markedly agreeing with the description of the species from Sri Lanka (Pegler 1986). Although both Corner (1966) and Pegler (1986) found the lamella-edge of *T. infundibuliformis* to be sterile, they did not find true cheilocystidia. The presence of fine grooves (canaliculations) at the edge of the deeply decurrent lamellae and the slightly larger spores distinguish this species from *T. buccinalis* (Mont.) Pat., another radially splitting species.

Tramal tissues of both the species treated here exhibited fusiform, inflated, thin- to slightly thick-walled generative hyphae together with frequently

branched, slender, septate hyphae, the hallmarks of Corner's sarcodimitic tissue.

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Literature cited

- Corner EJH. 1966. A monograph of cantherelloid fungi. Oxford, Oxford University Press.
- Corner EJH. 1991. *Trogia* (*Basidiomycetes*). The Garden's Bulletin, Singapore, Supplement 2: 1–100.
- Kornerup A, Wanscher JH. 1978. Methuen handbook of colour, 3rd edn. London, Methuen.
- Manjula B. 1983. A revised list of the agaricoid and boletoid basidiomycetes from India and Nepal. Proceedings of the Indian Academy of Sciences (Plant Sciences) 92: 81–213.
- Natarajan K, Kumaresan V, Narayanan K. 2005. A checklist of Indian agarics and boletes (1984–2002). Kavaka 33: 61–128.
- Pegler DN. 1986. Agaric flora of Sri Lanka. Kew Bulletin Additional Series 12: 1–519.
- Redhead SA. 1987. The *Xerulaceae* (*Basidiomycetes*), a family with sarcodimitic tissues. Canadian Journal of Botany 65: 1551–1562.
- Singer R. 1986. The *Agaricales* in modern taxonomy, 4th edn. Koenigstein, Koeltz Scientific Books.
- Wilson AW, Desjardin DE. 2005. Phylogenetic relationships in the gymnopoid and marasmioid fungi (*Basidiomycetes*, euagarics clade). Mycologia 97: 667–679.

Validation of *Moellerodiscus coprosmae*

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Abstract — When originally published, the protologue of *Moellerodiscus coprosmae* inadvertently referred to type specimens in two distinct collections, one a herbarium (PDD), the other a culture collection (ICMP). The ICMP culture had been derived from germinated ascospores taken from the specimen subsequently dried and deposited in PDD. Article 8.4 of ICBN (Vienna Code) allows that type specimens of fungi may be living cultures, thus two separate specimens were designated as the holotype. This paper validates the name by clarifying that the dried specimen PDD 64924 is the holotype, and that ICMP 14146 is a culture derived from the type.

Key words — nomenclature, *Rutstroemiaceae*, *Helotiales*

Johnston & Park (2002) proposed a new species, *Moellerodiscus coprosmae*. In the protologue, two different specimens were designated as the type, PDD 64924 and ICMP 14146. Although clear from the Methods that the ICMP specimen was a culture derived from the field collection PDD 64924, as ICBN Art. 8.4 (McNeill et al. 2006) allows living cultures to be designated as types for fungi, the protologue inadvertently designated two specimens in two different collections as the holotype. This is contrary to ICBN Art. 9.1 and 37.7, and hence the species name was invalidly published.

To validate this species, PDD 64924 is here designated as the holotype, and ICMP 14146 as a culture derived from the type. Following ICBN Art. 36.1, the Latin diagnosis and description is available from Johnston & Park (2002: 107–108).

Moellerodiscus coprosmae P.R. Johnst., sp. nov.

MYCOBANK MB512997.

“*Moellerodiscus coprosmae*” P.R. Johnst., New Zealand Journal of Botany 40: 107, 2002, nom. inval. (invalid holotypification). Mycobank MB375831.

HOLOTYPE: New Zealand: Auckland: Hunua Ranges, Waharau Regional Park, vic. education camp, on fallen leaves of *Coprosma robusta*, P.R. Johnston D1212, 7 Aug 1995, PDD 64924 (culture from type specimen, ICMP 14146).

Acknowledgements

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Literature cited

- Johnston PR, Park D. 2002. Three new species of *Moellerodiscus* (*Helotiales*, *Rutstroemiaceae*) from New Zealand. *New Zealand Journal of Botany* 40: 105–115.
- McNeill J, Barrie FF, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema J, Turland NJ. 2006. International Code of Botanical Nomenclature (Vienna Code). Adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. *Regnum Vegetabile* 146. 568 p.

A checklist of the aphyllorphoroid fungi (*Basidiomycota*) recorded from the Brazilian Atlantic Forest

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Abstract — The Atlantic Forest is one of the most diverse and threatened biomes of the world. A list with 733 species of aphyllorphoroid fungi reported from the Brazilian Atlantic Forest is presented based on an intensive search of literature records. These species are distributed in 219 genera and 47 families. *Polyporaceae* is the most highly represented family with 153 species; *Phellinus* is the genus with the highest number of species (42). The complete checklist is available on <http://www.mycotaxon.com/resources/weblists.html>.

Key words — *Aphyllorphorales*, macrofungi, neotropics

Introduction

The Atlantic Forest is a unique series of South American rainforest ecosystems, which also includes other distinct vegetation types, such as mangroves and ‘restinga’ (Mittermeier et al. 2005). This biome is located along the Atlantic coast of Brazil and inland into parts of Argentina and Paraguay. It once covered an area of approximately 1,300,000 km² (Pôrto et al. 2006), and it was present in 17 of the 27 states of Brazil. This rainforest is one of the most diverse regions and one of the most threatened environments of the world, since its area is now home to 67% of the Brazilian population and it is currently reduced to 7.26% of its original size, placing it among the five most important hotspots (Mittermeier 2005, SOS Mata Atlântica/INPE 2008).

Studies on aphyllorphoroid fungi in the Atlantic Forest started in the late 19th century with collections made by European naturalists traveling in Brazil (Fidalgo 1962). Many of these specimens were published by European mycologists (Berkeley 1842, Hennings 1902, 1904a,b; Patouillard 1907). Later, two Europeans made important contributions to the knowledge of the group in northeastern (Torrend 1920a,b, 1922, 1926, 1935) and southern Brazil (Rick 1907, 1924, 1959a,b, 1960). Unfortunately there is no reference or accurate data



FIGURE 1. Brazilian map showing the original domain of the Atlantic forest [modified from Capobianco (2001)]

about the collections' localities in many of these works. The great majority of recent studies on aphylloroid fungi in Brazil were carried out in the Atlantic Forest. The most important recent contributions have been made by research groups from the states of Pernambuco, Rio Grande do Sul, São Paulo, and Santa Catarina.

During the VI Latin-American Mycology Congress in 2008, a working group of Latin American researchers focused on the diversity of the aphylloroid fungi was created with a commitment to publish checklists on this group of fungi for areas or countries in Latin America. Following this commitment, Brazilian researchers are now providing these checklists (Drechsler-Santos et al. 2008, 2009; Gomes-Silva & Gibertoni 2009).

The aim of this work is to compile data on aphylloroid fungi from the Brazilian Atlantic Forest and to present a list of species recorded and their distribution in this biome. Although mangrove forests from the states of Rio Grande do Norte to Santa Catarina are included in the Atlantic Forest biome, their aphylloroid fungi were recently listed by Baltazar et al. (2009) and will not be treated in this checklist.

Material and methods

This checklist has been compiled based on an intensive search of literature records of the aphyllorphoroid fungi in the Atlantic Forest. Nomenclature and authors names are according to the following online databases: CBS (<http://www.cbs.knaw.nl/databases/aphyllo/database.aspx>), Index Fungorum (<http://www.indexfungorum.org/Names/Names.asp>) and the International Plant Names Index (<http://www.ipni.org>).

Genera and species are listed alphabetically within each family according to Kirk et al. (2008). Synonym is according to the Index Fungorum and CBS databases and exceptional cases are indicated as a comment in the respectively species. Species with taxonomic position not well established are placed in 'incertae sedis'. Taxa with unresolved nomenclature, or not found in the databases, are placed in 'nomina dubia', and those with non neo- or pantropical distributions were excluded. In this checklist, we considered aphyllorphoroid fungi as those species traditionally placed in *Aphyllorphorales* sensu Donk (1964).

Results

The 733 aphyllorphoroid species reported from the Brazilian Atlantic Forest are distributed among 219 genera and 47 families. The most represented family is *Polyporaceae* (153 species), followed by *Hymenochaetaceae* (103) and *Meruliaceae* (78). The genus with the highest number of recorded species is *Phellinus* (42 species), followed by *Hymenochaete* (27) and *Polyporus* (25).

A total of 22 species are considered incertae sedis, while 327 species names distributed in 75 genera are considered nomina dubia. Many of these species belong to synonymized genera and a study of their types is necessary to confirm their identities. Another 144 species distributed among 80 genera were excluded due their non neo- or pantropical distribution.

The Atlantic Forest is the most studied Brazilian biome concerning the aphyllorphoroid fungi, i.e. there are more works and species recorded from this biome than from the Brazilian Amazonia (Gomes-Silva & Gibertoni 2009) and the Brazilian semi-arid region (Drechsler-Santos et al. 2009). However, a critical review of specimens is needed to correct misidentifications and nomenclatural problems before it is possible to assert accurately how many species are known from the Atlantic Forest.

The complete checklist is available on <http://www.mycotaxon.com/resources/weblists.html>.

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Literature cited

- Baltazar JM, Trierveiler-Pereira L, Loguercio-Leite C. 2009. A checklist of xylophilous basidiomycetes (*Basidiomycota*) in mangroves. *Mycotaxon* 107: 221–224.
- Berkeley MJ. 1842. Notice of some fungi collected by C. Darwin Esq. in South America and the Islands of the Pacific. *Ann. Mag. Nat. Hist.* 9(60): 443–448.
- Capobianco JPR. 2001. Dossiê Mata Atlântica, 2001. São Paulo, Instituto Socioambiental.
- Donk MA. 1964. A conspectus of the families of *Aphylllophorales*. *Persoonia* 3: 199–324.
- Drechsler-Santos ER, Groposo C, Loguercio-Leite C. 2008. Additions to the knowledge of lignocellulolytic *Basidiomycetes* (*Fungi*) in forests from Santa Catarina State, Brazil. *Mycotaxon* 103: 197–200.
- Drechsler-Santos ER, Gibertoni TB, Góes-Neto A., Cavalcanti MAQ. 2009. A re-evaluation of the lignocellulolytic *Agaricomycetes* from the Brazilian semi-arid region. *Mycotaxon* 108: 241–244.
- Fidalgo O. 1962. Rick, o pai da Micologia brasileira. *Rickia* 3: 1–44.
- Gomes-Silva A, Gibertoni TB. 2009. Checklist of the aphylllophoraceous fungi (*Agaricomycetes*) of the Brazilian Amazonia. *Mycotaxon* 108: 319–322.
- Hennings P. 1902. Fungi S. Paulenses II a cl. Puttemans collecti. *Hedwigia* 41: 295–311.
- Hennings P. 1904a. Fungi fluminenses a cl. E. Ule collecti. *Hedwigia* 43: 78–95.
- Hennings P. 1904b. Fungi S. Paulenses III a cl. Puttemans collecti. *Hedwigia* 43: 197–209.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Ainsworth and Bisby's dictionary of the fungi. 10th ed. Wallingford, CAB International.
- Mittermeier RA, Gil PR, Hoffmann M, Pilgrim J, Brooks T, Mittermeier CG, Lamoreux J, Fonseca GAB. 2005. Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. Belo Horizonte, Conservation International – Brazil.
- Patouillard N. 1907. *Basidiomycètes* nouveaux du Brésil recueillis par F. Noack. *Ann. Mycol.* 5(4): 364–366.
- Pôrto KC, Almeida-Cortez JS, Tabarelli MT. 2006. Diversidade Biológica e Conservação da Floresta Atlântica ao Norte do Rio São Francisco. Brasília, Ministério do Meio Ambiente.
- Rick J. 1907. Contributio ad monographiam *Agaricearum* et *Polyporacearum* Brasiliensium. *Broteria*, Ser. Bot. 6: 65–96.
- Rick J. 1924. Contributio ad monographiam *Polyporacearum* riograndensium II. *Broteria*, Ser. Bot. 21: 5–11.
- Rick J. 1959a. *Basidiomycetes* eubasidii in Rio Grande do Sul – Brasilia. 2. *Thelephoraceae*. *Iheringia*, Bot. 4: 61–124.
- Rick J. 1959b. *Basidiomycetes* eubasidii in Rio Grande do Sul – Brasilia. 3. *Hypochnaceae*, *Clavariaceae*, *Craterellaceae*, *Hydnaceae*. *Iheringia*, Bot. 5: 125–192.
- Rick J. 1960. *Basidiomycetes* eubasidii in Rio Grande do Sul – Brasilia. 4. *Meruliaceae*, *Polyporaceae*, *Boletaceae*. *Iheringia*, Bot. 7: 193–295.
- SOS Mata Atlântica, Instituto Nacional de Pesquisas Espaciais. 2008. Atlas dos remanescentes florestais da Mata Atlântica, Período 2000 a 2005. <<http://www.sosmatatlantica.org.br>>.
- Torrend C. 1920a. Les Polyporacées du Brésil. Le genre *Ganoderma*. *Broteria*, Ser. Bot. 18(1): 23–42.
- Torrend C. 1920b. Les Polyporacées du Brésil. Polyporacées stipitées. *Broteria*, Ser. Bot. 18(1): 121–142.
- Torrend C. 1922. Les Polyporacées du Brésil. Les genres *Amauroderma* et *Lignosus*. *Broteria*, Ser. Bot. 18(2): 21–42.
- Torrend C. 1926. Les Polyporacées stipitées du Brésil. *Broteria*, Ser. Bot. 22(1) : 74–88.
- Torrend C. 1935. Les Polyporacées du Brésil. *Broteria*, Ser. Bot. 31(3): 108–120.

Ascription of poorly defined taxa to taxonomic entities using molecular phylogenies: a case study on *Nodulisporium* sp. producers of nodulisporic acid

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Abstract — DNA sequences of the ITS1-5.8S-ITS2 region, β -tubulin, and α -actin genes were obtained from a set of *Nodulisporium* sp. isolates producing the potent anti-parasitic agent, nodulisporic acid, and other related strains. These sequences were used to confirm the molecular homogeneity of these NA-producers, to determine their most closely related taxa within genus *Hypoxylon*, and to explore the phylogenetic relationships between these strains and other hypoxyloid sequences from public DNA databases. The results from all the loci analyzed show that this group of strains constitutes a monophyletic taxon. This taxon would be included within a cluster containing endophytic, tropical xylariaceous isolates lacking defined teleomorph and taxonomic status, together with several *Hypoxylon* species such as *H. investiens*, *H. kanchanapisekii*, and *H. anthochroum*.

Key words — phylogeny, *Xylariales*, xylariaceous

Introduction

The comparison of DNA sequences is an objective method for establishing phylogenetic affinities among strains isolated in different laboratories all over the world. Despite the current initiatives claiming to select a gene as a universal bar-coding marker, in practice each laboratory has its own criteria for choosing a determined gene or group of genes to assess the genetic affinities among strains of interest. This approach is very useful in building phylogenies when no previous information is available. Where previous information exists, these new phylogenies could miss important information otherwise obtained from

comparison of other gene sequences from related cultures already stored in DNA databases.

The genus *Hypoxylon* serves as good example of this situation. During the last decade, a substantial number of works have been published describing a new *Hypoxylon* species or inferring phylogenetic relationships within *Hypoxylon* using the ITS1-5.8S-ITS2 region (e.g. Sánchez-Ballesteros et al. 2000, Lee et al. 2000, Mazzaglia et al. 2001, Guo et al. 2000, Promputtha et al. 2005, Suwannasai et al. 2005, Triebel et al. 2005, Peláez et al. 2008). On the other hand, Hsieh et al. (1995) published a comprehensive paper comparing sequences of two nuclear genes, β -tubulin and α -actin, from 109 strains and 3 specimens representing 83 taxa of *Xylariaceae*. However, only a few *Hypoxylon* species are represented by these three genes in GenBank, and usually the sequences are derived from different isolates (some of which may even have been misidentified), which might lead to wrong conclusions arising from incorrect information in new phylogenetic studies.

Our study revises the taxonomic position of a set of isolates representing a possibly undescribed *Nodulisporium* taxon producing nodulisporic acid (NA) (Polishook et al. 2001) by comparing the sequences of three different genomic regions — ITS, β -tubulin, and α -actin — with homologous sequences available in GenBank. Nodulisporic acid (Ondeyka et al. 1997) is an indole diterpene with very potent oral anti-flea activity in dogs that lacks overt mammalian toxicity (Ostlind et al. 1997, Shoop et al. 2001). Nodulisporic acid acts by activating a glutamate-gated chloride channel in insects (Smith et al. 2000). After the discovery of NA, six additional compounds from the same family were isolated from fermentation broths of the same producing strain (Ondeyka et al. 2002, Singh et al. 2004). Other derivatives have been chemically synthesized (Smith et al. 2006a,b, 2007a,b). NA biosynthesis research by Byrne et al. (2002) shows indole-3-glycerolphosphate as the precursor of the NA indole moiety, and Ireland et al. (2008) have recently reported the tryptophan synthetase gene related to NA production.

Nodulisporic acid was detected in extracts derived from 13 fungal strains isolated from different natural substrata from seven tropical locations in four continents. Detailed analyses of micromorphology and metabolic profiles, as well as of ITS sequences allowed their classification as members of a possible new biological species of the genus *Nodulisporium*, but no specific epithet has been assigned to this species. Although its teleomorph is still unknown, comparison of ITS sequences from other xylariaceous fungi suggested that it would most likely be a *Hypoxylon* species near *H. fendleri* Berk. ex Cooke (Polishook et al. 2001).

ITS region sequence data show isolates arranged into three groups according to ITS1 lengths of 210, 302, and 346 nucleotides respectively, due to a VNTR

(Variable Number of Tandem Repeats) polymorphism. Tandem repeats vary in number from two to five repetitions per isolate. Repeated units are rather variable and encompass three tandem repeated motifs of 11 nucleotides. The different size of this subunit could be explained by slipped-strand mispairing occurrences (Platas et al. 2002). In contrast, ITS2 sequences were much more homologous. These data suggest that all isolates could be considered as representing the same taxon, although divided into populations showing some degree of genetic differentiation.

Materials and methods

Fungal strains

Of 13 *Nodulisporium* sp. strains producing NA (Polishook et al. 2001) investigated, 3 were excluded as representing duplicates and 10 were selected for this analysis. All these strains are coded with their accession numbers in the Merck Culture Collection (MF); those included in this study accompanied by their geographical origin, ITS1 gene size, and GenBank sequence accession numbers are listed in TABLE 1.

DNA extraction, PCR amplification and sequencing

DNA was extracted according to Peláez et al. (1996). The ITS1-5.8S-ITS2 region was amplified using universal primers ITS4 and ITS5 (White et al. 1990). β -tubulin and a fragment of α -actin genes were obtained using PCR primers T1/T22 (O'Donnell & Cigelnik 1997) and ACT-512F/ACT-783R (Carbone & Kohn 1999) respectively. PCR amplification followed standard procedures (40 cycles of 30 s at 93°C, 30 s at 53°C, 2 min at 72°C). About 0.1 μ g/ml of the double stranded amplification products were sequenced using the ABI PRISM Dye Terminator Cycle Sequencing Ready Reaction Kit (Perkin Elmer, Norwalk CT) following manufacturer recommended procedures. Purified PCR products were directly sequenced using the same primer pairs as in the PCR reactions. Inner primers were used to complete the sequence of β -tubulin gene: T21, T10, T11, T12 and T224 (O'Donnell & Cigelnik 1997). An additional primer bt_1 5'-CTTATGTTTACTGCTGACCC-3' derived from the 5' end of an initial β -tubulin sequence alignment was developed to amplify DNA of species that failed in the initial attempt. Partial sequences obtained in sequencing reactions were assembled with Genestudio 2.1.1.5. (Genestudio, Inc., Suwanee, GA, USA). DNA sequences were aligned with Genestudio 2.1.1.5. Multiple alignments were deposited in TreeBASE with number SN4083.

Culture description

Culture descriptions and morphology were observed directly using an optical microscope (Leica DML52) with an image capture device. Microscope slides of the fungal cultures (including either somatic mycelia or conidiogenic structures) were prepared under a binocular lens Leica Wild M3C with cold light device and mounted in distilled water or lactophenol-cotton blue as needed. Cultures were identified by direct observation and measurements of the vegetative and reproductive structures.

TABLE 1. Isolates studied.

SPECIES	STRAIN CODE	SUBSTRATE	COUNTRY	ITS1 SIZE	GENBANK ACCESSION NUMBERS		
					ITS1-5.8S-ITS2	β-TUBULIN	α -ACTIN
<i>Annulohypoxylon multiforme</i>	F160843		USA	193	FJ185303	FJ185282	-
<i>Annulohypoxylon cohaerens</i>	F160842		USA	190	FJ185301	FJ185283	FJ185264
<i>Annulohypoxylon cohaerens</i>	F119894	<i>Quercus faginea</i>	Spain	190	FJ185302	FJ185286	FJ185267
<i>Daldinia concentrica</i>	F090108		Papua New Guinea	177	FJ185300	FJ185285	FJ185280
<i>Nodulisporium</i> sp.	MF6245	Lichen	Puerto Rico	210	AF201756	FJ185296	FJ185272
<i>Nodulisporium</i> sp.	MF6263	Bush twigs	Colombia	346	AF201749	FJ185292	FJ185273
<i>Nodulisporium</i> sp.	MF6324	Dead leaves	Peru	210	AF201759	FJ185289	FJ185276
<i>Nodulisporium</i> sp.	MF6321	Leaf litter	Mauritius Island	346	AF201751	FJ185297	FJ185275
<i>Nodulisporium</i> sp.	MF6377	<i>Scaevola plumieri</i>	Eq. Guinea	210	AF201757	FJ185287	FJ185277
<i>Nodulisporium</i> sp.	MF6378	<i>Anacardium occidentale</i>	Eq. Guinea	210	AF201760	FJ185295	FJ185278
<i>Nodulisporium</i> sp.	MF6379	<i>Dorstenia elliptica</i>	Eq. Guinea	210	AF201761	FJ185290	FJ185279
<i>Nodulisporium</i> sp.	MF5954 ATCC 74245	Stems of <i>Bontia daphnoides</i>	Hawaiian Islands	302	AF201753	FJ185291	FJ185270
<i>Nodulisporium</i> sp.	MF6230	Horse dung	Marquesas Islands	302	AF201752	FJ185288	FJ185271
<i>Nodulisporium</i> sp.	MF6315	Leaf litter from coffee plant	Mauritius Island	302	AF201754	FJ185293	FJ185274
<i>Nodulisporium</i> sp.	F089878	Jungle pond	French Guyana	210	FJ185305	FJ185294	FJ185268
Hypoxyloid isolate	JP5613 CBS 123520	Oregano leaves	Mexico	184	FJ185306	FJ185284	FJ185269
<i>Hypoxylon subrutiloides</i>	F202416	Fallen wood	New Zealand	210	FJ185304	FJ185281	FJ185263
<i>Hypoxylon investiens</i>	CBS 118183		Malaysia	254	FJ185307	FJ185298	FJ185265
<i>Hypoxylon investiens</i>	CBS 118185		Ecuador	258	FJ185308	FJ185299	FJ185266

Phylogenetic analysis

Bayesian inference and Markov chain Monte Carlo simulations (MCMC) were used to generate phylogenetic hypotheses from individual gene data sets using MrBayes 3.01 (Huelsenbeck et al. 2002, Ronquist & Huelsenbeck 2003). To improve mixing of the chain, four incrementally heated simultaneous MCMCs were run over 2,000,000 generations. MrModeltest 2.2 (Nylander 2004) was used to perform hierarchical likelihood ratio tests to calculate the Akaike information criterion (AIC) values of the nucleotide substitution models. The HKY+I+G model was selected by AIC for aligning the β -tubulin and α -actin gene fragment that allowed two classes of substitution types, a portion of invariant alignment positions, and mean substitution rates varying across the remaining positions according to a gamma distribution. Due to the high ITS1 variability in the *Xylariales* found in previous studies (Platas et al. 2000), the ITS1 section containing tandem repeats was removed from analysis. The HKY+G model was selected by AIC for aligning the ITS1-5.8S-ITS2 fragment, which allowed two classes of substitution types and mean substitution rates varying across the remaining positions according to a gamma distribution. Priors used for the MCMC process were a Dirichlet distribution for substitution rates and nucleotide frequencies, and a uniform prior for the rate parameter of the gamma distribution. For all these analyses, the sampling frequency at which the trees were stored was 100, the 1000 first trees were discarded, and a majority rule consensus tree was obtained.

Induction of ascoma production

A method was introduced to artificially induce production of the teleomorph state of the NA-producing *Nodulisporium* sp. and the hypoxylloid strain JP5613. Control strains of *Hypoxylon investiens* (Schwein.) M.A. Curtis were tested in the same conditions. The fungal strains were inoculated into 3–6-year old sterilized twigs (3–5 cm diam \times 8–10 cm long) taken from healthy *Citrus aurantium* L. and *C. reshni* Hort. ex Tanaka. As members of the *Xylariales* are believed to be heterothallic, several fungal strains were inoculated into the same wood pieces to induce ascoma production. Fungal inoculum of millet grain colonized by the fungi in solid-state fermentation conditions was subsequently dehydrated and inserted into holes drilled in the wood. Inoculated branches were then incubated in sterilized flasks at room temperature for 120 days.

Results

Comparison of ITS-5.8S-ITS region with in-house DNA sequence databases

As the ITS1 sequence of the NA-producers was shown to be very variable (Platas et al. 2002), the NA-producer ITS2 sequences, which showed 94–100% homology among the isolates, was used to find similar sequences within our proprietary DNA database using BLAST analysis. The list of best matches and the percentage of similarity includes: *Nodulisporium* sp. F089878 (96–100%), xylariaceous sp. JP5613 (88–91%), *Annulohypoxylon cohaerens* (Pers.) Y.M. Ju et al. F119894 & F160842 (79–81 %), *Annulohypoxylon multifforme* (Fr.) Y.M. Ju et al. F160843 (78–80%), *Daldinia concentrica* (Bolton) Ces. & De Not. F090108 (75–77% homology), and *Hypoxylon subbrutillodes* Y.M. Ju & J.D.

Rogers F202416 (75–77%). All these strains were selected for the amplification of β -tubulin and α -actin genes.

PCR amplification of the ITS, α -actin and β -tubulin genes

Amplification of the ITS region and α -actin gene fragment was successful for all except *Annulohypoxylon multifforme* F160843, whose α -actin gene could not be amplified. Initially, β -tubulin gene amplification was not successful in *Nodulisporium* sp. MF6245, MF6263, and MF6321, *Annulohypoxylon multifforme* F160843, and *Daldinia grandis* Child F090108 using the primer combination T1/T22. A new primer (bt_1) was designed based upon the sequences from the 5' end of the gene, which combined with primer T22 successfully amplified the remaining strains.

Sequence comparisons and BLAST analyses

The similarity percentage range between the NA-producing *Nodulisporium* sp. for β -tubulin (1466 bp) and α -actin (268 bp) gene sequences was 94–100%. The similarity range between *Nodulisporium* sp. strain F089878 and the NA-producers was within the same interval (94–100%) for both genes. This data, together with the morphological observations (see below), confirmed initial conclusions based on the ITS2 sequence, suggesting that isolate F089878 would be co-specific with the NA-producers. Strain JP5613 showed 87–88% similarity for β -tubulin and 79–80% for α -actin gene. Similarities found among the remaining sequenced isolates were not significant.

A BLAST analysis of α -actin and β -tubulin NA-producer gene sequences was performed against GenBank. The best matching sequences were aligned, and preliminary phylograms were obtained using MCMC analysis. In the phylograms obtained using both genes (data not shown), the clade of NA-producing *Nodulisporium* sp. strains clustered together with *Hypoxylon investiens* BCRC34074 from Taiwan (87–90% similarity for α -actin and 87–88% for β -tubulin respectively). For confirmation, two new *H. investiens* strains from Malaysia (CBS 118183) and Ecuador (CBS 118185) were included and their ITS region, β -tubulin, and α -actin gene fragments were sequenced. These two strains showed a homology with the published *H. investiens* sequences of 92–95% (β -tubulin) and 94–96% (α -actin). The similarity percentage between these two isolates for the whole ITS1-5.8S-ITS2 region was 90%, confirming the high variability previously found in the ITS of conspecific *Xylariales* (Sánchez-Ballesteros et al. 2000). The similarity range between the ITS2 of those strains with the NA-producers was 84–92%.

BLAST analysis of the NA-producer ITS1-5.8S-ITS2 regions against GenBank revealed significant matches with sequences of some endophytic strains or herbarium specimens, mainly from tropical Asia. The best matches included

GenBank AF153746 and AF153742, two different morphospecies isolated from *Livistona chinensis* (Jacq.) R. Br. now assigned to the *Xylariales* (Guo et al. 2000). Another related ITS sequence (DQ485958) belongs to a xylariaceous endophyte from *Magnolia liliifera* Baill. tentatively classified within *Hypoxylon* near *H. fendleri* by Promputtha et al. (2005). All these sequences correspond to strains lacking any known teleomorph. Together with these xylariaceous endophytes, BLAST analysis found also matches with several *Hypoxylon* spp.: *H. rubiginosum* (Pers.) Fr. (DQ233758, DQ233759), *H. anthochroum* Berk. & Broome (DQ201125, DQ201126), and *H. kanchanapisekii* Suwann. et al. (DQ233741, DQ233742, DQ233743). Unfortunately, none of these strains were available for further studies.

Phylogenetic analyses

Bayesian analyses of β -tubulin and α -actin sequence alignments were performed including sequences obtained from: i) 11 NA-producing *Nodulisporium* sp isolates; ii) *Nodulisporium* sp. F089878; iii) xylariaceous strain JP5613; iv) *H. investiens*, the presumed closest relative to the NA-producers; v) *Annulohypoxylon cohaerens* F119894 and F160842, *A. multiforme* F160843, *Daldinia concentrica* F090108, and *Hypoxylon subbrutillodes* F202416, whose ITS2 genes were retrieved as best matches with the NA-producing strain sequences from our in-house DNA database; and vi) three groups of sequences representing miscellaneous taxa from *Hypoxylon* s. str., *Annulohypoxylon*, and *Daldinia* that were the best matches from the GenBank BLAST search. In addition, a third phylogenetic ITS sequence analysis was performed for Strains (i)–(v) above and sequences from assorted xylariaceous fungi ranked as best BLAST search matches with the NA-producing strains.

α -actin and β -tubulin phylogenies

In general, the arrangement of the NA-producing strains in the phylogenetic trees derived from the α -actin (FIG. 1) and β -tubulin (FIG. 2) gene fragments was consistent with previous ITS sequence studies (Polishook et al. 2001). All formed a natural monophyletic group, suggesting their ascription to a single biological species.

Both phylogenetic trees placed *H. investiens* as the closest relative of the NA-producing strains, together with xylariaceous isolate JP5613. All sequences fell into a clade with high credibility support in both trees. However, evolutionary relationships of these isolates with the other hypoxylid genera remain unclear. Thus, the α -actin based phylogeny suggests (without clade credibility support) a relationship between NA-producers and one node containing *Hypoxylon* s. str. taxa, whereas the β -tubulin phylogenetic reconstruction topology shows a clade containing *Annulohypoxylon* species as the group most closely related to the NA-producers, supported with 98% clade credibility.

Both phylogenetic trees are consistent with the well-known heterogeneity of *Hypoxylon* s. lat. (Sánchez-Ballesteros et al. 2000, Hsieh et al. 2005, Peláez et al. 2008). In both trees, *Daldinia* and *Annulohypoxylon* spp. sequences group in two well supported clades, confirming data from Hsieh et al. (2005), but taxa representing the modern concept of *Hypoxylon* s. str. occur on several separate branches, suggesting a polyphyletic origin.

Distribution of NA-producing strains within their clade differs in both phylogenetic trees. In both trees, isolates with a medium to large ITS1 intermingle and cluster consistently as a monophyletic group with total bootstrap support, but the distribution of isolates with a small ITS1 differs. They form a monophyletic group without statistical support in the α -actin based phylogeny but split into two groups in the β -tubulin based tree.

With few exceptions, distribution of the NA-producing strains in the trees does not correlate with geographic origin. For instance, two (MF6377, MF6378) of the three sequences from Equatorial Guinea group together in both trees with the third isolate (MF6379) more distant. Within the group of short ITS1 sequence isolates, isolate F089878 clusters with strain MF6245, which could reflect their close geographic origins (French Guyana and Puerto Rico, respectively). Interestingly, in both phylogenies, the two isolates from Mauritius Island (MF6315, MF6321) cluster together within a well supported clade despite their different ITS1 sizes.

ITS phylogeny

In the phylogram generated from the ITS sequence analyses (FIG. 3), the NA-producing strains form a monophyletic group with high credibility support, as expected. The NA-producers are distributed according to their ITS1 size in two well supported monophyletic clades, with the small ITS1 strains separate from medium-large ITS1 strains, as already reported (Polishook et al. 2001). This clade also includes *Nodulisporium* sp. strain F089878 as well as a sequence from an unidentified xylariaceous fungus (AF153746) isolated from *Livistona chinensis* (Guo et al. 2000).

The clade containing the NA-producing strains falls within a larger branch with high (97%) clade credibility support that also includes sequences from several *Hypoxylon* species (e.g., *H. kanchanapisekii*, *H. anthochroum*, *H. investiens*, *H. rubiginosum*) and several undetermined xylariaceous fungi. Two undetermined xylariaceous (AF153742, DQ485958) sequences cluster with *H. investiens* sequences in a well-supported clade. Interestingly, *Hypoxylon fendleri*, the closest reported match to the NA-producing strains (Polishook et al. 2001), occurs outside this clade.

A sister clade to this large monophyletic group, supported with 100% of clade credibility, comprised sequences from *H. rubiginosum*, *H. petriniae* M.

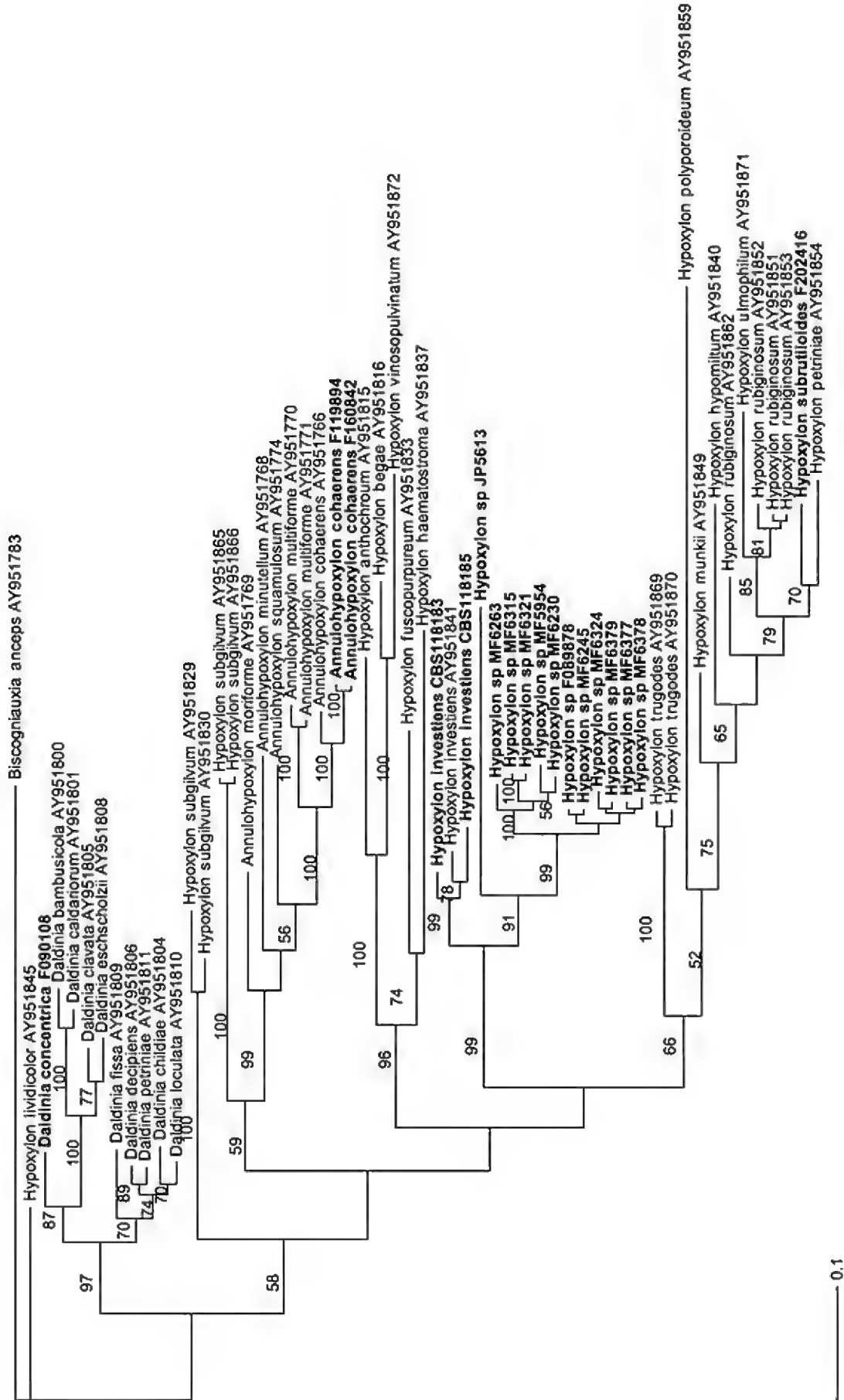


FIGURE 1. 50% majority rule consensus cladogram showing the phylogenetic relations for the Nodulisporic Acid producers and other hypoxylloid taxa, inferred from α -actin gene fragment performed sequences with a Bayesian analysis. Branch numbers show Credibility Clade Support. The tree alignment contained 338 characters (146 constant). Tree length = 1002 steps.

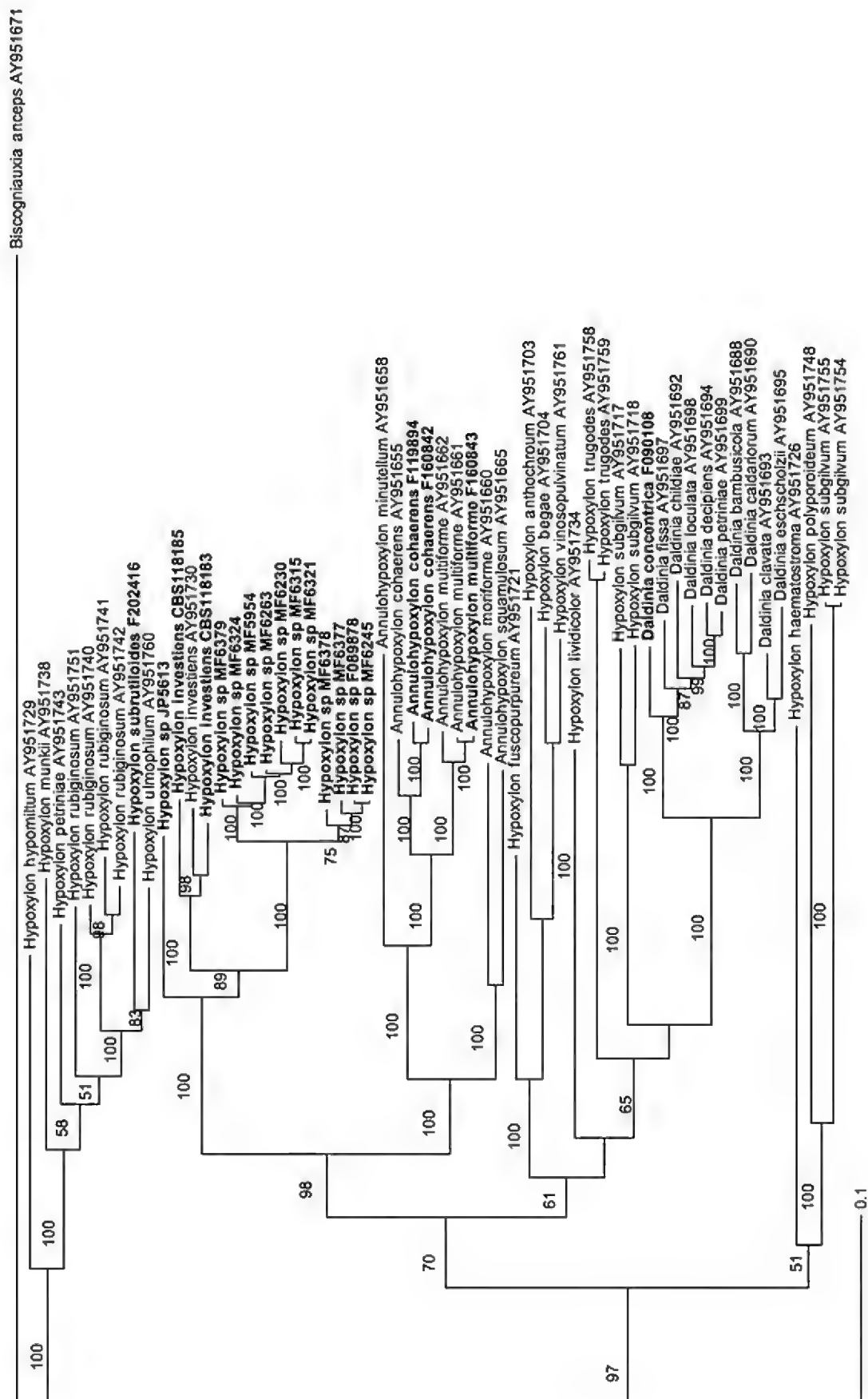


FIGURE 2. 50% majority rule consensus cladogram showing the phylogenetic relations for the Nodulisporic Acid producers and other hypoxylid taxa, inferred from β -tubulin gene sequences performed with a Bayesian analysis. Branch numbers show Credibility Clade Support. The tree alignment contained 1659 characters (808 constant). Tree length = 4762 steps.

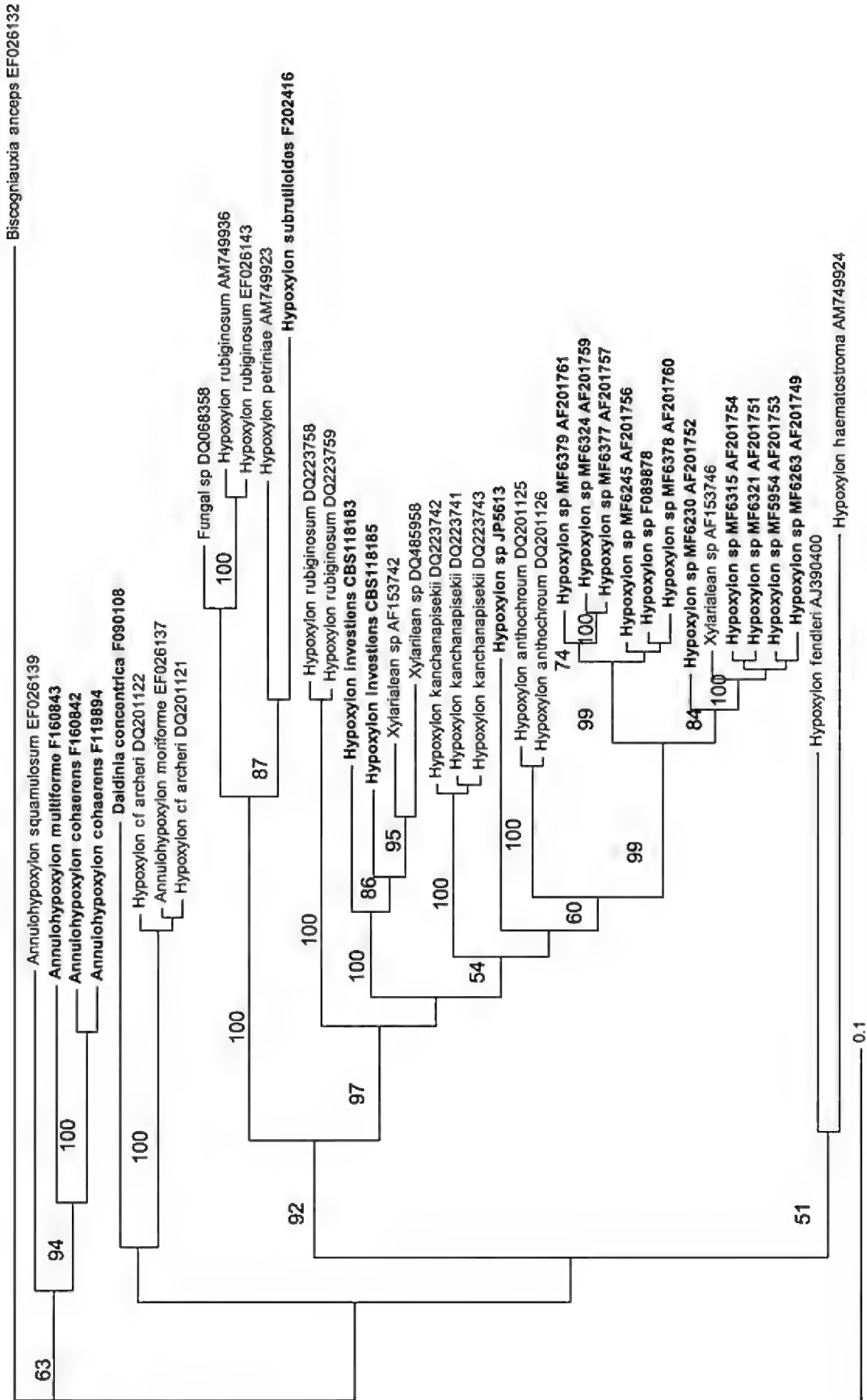


FIGURE 3. 50% majority rule consensus cladogram showing the phylogenetic relations for the Nodulisporic Acid producers and other hypoxylid taxa, inferred from ITS1 (partial)-5.8S-ITS2 gene sequences performed with a Bayesian analysis. Branch numbers show Credibility Clade Support. The tree alignment contained 509 characters (293 constant). Tree length = 621 steps.

Stadler & J. Fourn. and *H. subbrutiloides*, together with an undetermined fungal species (DQ068358).

Morphological features

Despite our attempts to induce teleomorph production by growing the NA-producing strains on wood twigs, no stromata or perithecia developed under the tested conditions. Thus, plated colonies were examined for morphological features common to the phylogenetically related taxa. As previously reported (Polishook et al. 2001), cultural characters of the NA-producing strains were remarkably homogeneous. All strains shared the same optimal growth temperature (37°C), the distinctive (i.e., “*Nodulisporium*-like”) and characteristically sweet aromatic odour, and a *Nodulisporium* anamorph composed of mononematous, erect conidiophores that are penicillately branched (verticillate), covered in patches by a brown melanin-like parietal pigment and with conidiogenous minutely verruculose and cylindrical terminal and holoblastic conidiogenous cells bearing oblong-elliptical, smooth, hyaline conidia that fail to grow after germination, are produced sympodially from the conidiogenous cell apices, and accumulate in apical clusters. Another common feature was the abundant brownish-black soluble pigment produced in both plate and liquid culture.

Isolate F089878, a xylariaceous endophyte from French Guyana, produced colonies indistinguishable from the NA-producing strains with respect to *Nodulisporium* anamorph morphology, optimal growth temperature, and pigment production. These findings — consistent with the results derived from DNA sequence analyses— suggest that isolate F089878 is conspecific with the NA-producers, although nodulisporic acid production has not yet been verified.

Hypoxyloid fungus JP5613 (isolated from *Origanum* leaves from Mexico) differed macroscopically. This fungus produced whitish to pale grey-white colonies lacking the characteristic sweet “*Nodulisporium*-like” odour. Furthermore, the *Nodulisporium* anamorph was not observed in any of the cultures, where only intercalary and/or terminal chains of globose, thick-walled chlamydospores were seen. Although not very common in the genus, these resistance structures have been reported for some *Hypoxyton* species, such as *H. ticinense* L.E. Petrini, *H. subticinense* Y.M. Ju & J.D. Rogers (Ju & Rogers 1996) and *H. haematostroma* Mont. (Rogers et al. 1987).

Together with these isolates, two *Hypoxyton investiens* strains (CBS 118183, CBS 118185) were also examined in plate culture. These strains exhibited greenish olivaceous tones when young, becoming hazel with creamy-white margins at the maturity, different than the light orange yellow to pale reddish tones recorded for NA-producer strain cultures. Moreover, *H. investiens*

produces in culture a fertile, *Periconiella*-like anamorph (Ju & Rogers 1996) different from the *Nodulisporium* anamorph observed in the NA-producers.

Concerning *H. kanchanapisekii*, no descriptions of anamorph morphology were found in the literature and no strains were available allowing comparison with the NA-producers.

Discussion

Phylogenetic species recognition has become a powerful inference tool to detect taxa that are cryptic or poorly defined based on traditional diagnostic features (Taylor et al. 2000). There are numerous examples of fungal groups where analyses of multiple gene sequence data have allowed recognition of existing genetic diversity in genera like *Aspergillus* (Geiser et al. 2007), *Lasiosphaeria* (Miller & Huhndorf 2004), and *Neurospora* (Dettman et al. 2003) or species complexes such as *Neurospora discreta* D.D. Perkins & N.B. Raju (Dettman et al. 2006), and *Serpula himantoides* (Fr.) P. Karst. (Kauserud et al. 2005).

As stated above, the NA-producing strains included in this study shared a similar culture phenotype despite their different substrates and geographical origins. In addition, those strains consistently formed a monophyletic taxon based on phylogenetic analyses of three sets of sequences (ITS region, β -tubulin gene, α -actin partial gene). The relative position of the NA-producers in the phylograms supports the existence of a biological or phylogenetic species clearly differentiated from other related taxa by nucleotide divergence rates in several independent loci.

The NA-producers have an unusually variable ITS1 size caused by VNTR duplications. Duplication of this VNTR may have taken place independently in different populations. Isolates MF6321 (ITS1 size 346 bp) and MF6315 (302 bp), both recovered from samples collected in Mauritius Island, clustered together in the β -tubulin and α -actin gene phylograms (FIGS. 1–2). Moreover, they have identical mutations in the second and third tandem repetitions. Thus, our data suggest that MF6321 is more closely related to MF6315 than to the only other large ITS1 isolate (MF6263 from Colombia).

Xylariaceous strain MS1095 (sequence AF153746) appears most likely conspecific with the NA-producing strains. Its medium-sized ITS1 sequence (292 bp) clusters in the NA-producers clade with the medium- to large-sized ITS1 strain sequences (FIG. 3). Unfortunately this strain is no longer available for study, so we could not check for NA production.

This ITS1 size variation is not unique to NA-producers. The ITS1 sequences of *Hypoxylon investiens* and *Hypoxylon* sp. DQ485958 also show an unusual length. Strain CBS 118183 has 9 tandem repeated motifs plus one degenerate repetition, and CBS 118185 and *Hypoxylon* sp. DQ485958 sequences have 10 tandem repeated motifs.

In contrast with previous studies (Polishook et al. 2001), which suggest *H. fendleri* as the most closely related taxon, our newly obtained molecular sequence data indicate a close relationship between NA-producers and other tropical *Hypoxylon* and xylariaceous endophytes. *Hypoxylon investiens*, *H. kanchanapisekii*, *H. anthochroum* DQ223758-9 and *H. rubiginosum* DQ201125-6 appear to be the most closely related to the NA-producing xylariaceous fungi. Compared to the NA-producing species, *Hypoxylon investiens* develops a *Periconiella*-like anamorph in culture and has a different geographical distribution, including temperate zones of the Northern Hemisphere. *Hypoxylon kanchanapisekii*, with no reported anamorphic state, is a recently described taxon inhabiting bamboo stems from Thailand that is morphologically close to *H. parksianum* Y.M. Ju & J.D. Rogers (Suwannasai et al. 2005). *Hypoxylon investiens* and *H. parksianum* also share some features that place them close in morphological taxonomic keys (Ju & Rogers 1999). *Hypoxylon anthochroum* and *H. rubiginosum* have been considered as synonymous by some authors (e.g. Miller 1961), although results from other studies (e.g. Ju & Rogers 1996, Hsieh et al. 2005) do not support that synonymy. Our α -actin and β -tubulin phylograms and other consistent results (Hsieh et al. 2005) show *H. anthochroum* as quite distant from *H. investiens*, while the ITS phylogeny seem to suggest a closer relationship.

The ITS phylogeny clusters the *H. rubiginosum* sequences on two separate branches (two each, respectively). The *H. rubiginosum* sequences included in the *H. petriniae*-*H. subrutiloides* cluster originated from two different studies, and their position in the trees is consistent with previous data derived from α -actin and β -tubulin sequence data (Hsieh et al. 2005). However, two different *H. rubiginosum* strains belong to a clearly separate clade. This could either be due to misidentification of some of the sequence data or reflect the well-known heterogeneity of this taxon, usually considered as a large species complex, where numerous varieties have been split into different new taxa (Petrini & Müller 1986). This would be the case for *H. rubiginosum* var. *cercidicola* (Berk. & M.A. Curtis) L.E. Petrini (Petrini & Müller 1986) and *H. cercidicola* (Berk. & M.A. Curtis) Y.M. Ju & J.D. Rogers (Granmo 1999), two homotypic synonyms representing *Diatrype cercidicola*, which now accommodates isolates with thin, vinaceous stromata and *Virgariella*-like anamorphs that have a secondary metabolite profile clearly different from *H. rubiginosum* (Stadler et al. 2004). The separation of *H. petriniae* from *H. rubiginosum* is supported by the results shown in FIGS. 1–3.

According to our data above, the NA-producing species must be assigned to genus *Hypoxylon* s. str. Previous studies have suggested that the NA-producers belong to a unique and complex biological species. Thus, Triebel et al. (2005), using 5.8S-ITS phylogenies, observed that the NA-producers constitute a defined

clade, separate from other hypoxyloid taxa, both containing specific ITS1 and ITS2 sequence. In addition, unpublished results cited in Stadler & Hellwig (2005) indicate that these isolates produce neither naphthalens nor melleins, metabolites usually found in the two main lineages in the *Hypoxyloideae*. To our knowledge, *H. investiens* and *H. kanchanapisekii* have not been tested for the production of those compounds. It would be interesting to know whether these species, which appear more or less related to NA-producers based on sequence analyses, also share this chemotaxonomic feature. If so, this could provide an additional evidence for segregation of the NA-producers and related taxa from *Hypoxylon* s. str.

In summary, this work presents evidence for the phylogenetic recognition of an endophytic, hypoxyloid, pantropical undescribed species that produces nodulisporic acid. This is another example of the usefulness of molecular methods to detect and define new taxonomical entities, especially in those cases where diagnostic data from both teleomorphic and anamorphic states are scarce or even unavailable, and where other evidence (e.g., metabolic profiles, cultural features) suggests the existence of an undescribed taxon.

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Literature cited

- Alfaro ME, Zoller S, Lutzoni F. 2003. Bayes or bootstrap? A simulation study comparing the performance of Bayesian Markov chain Monte Carlo sampling and bootstrapping in assessing phylogenetic confidence. *Molecular Biology and Evolution* 20: 255–266.
- Byrne KM, Smith SK, Ondeyka JG. 2002. Biosynthesis of nodulisporic acid A: precursor studies. *Journal of the American Chemical Society* 124: 7055–7076.
- Dettman JR, Jacobson DJ, Turner E, Pringle A, Taylor JW. 2003. Reproductive isolation and phylogenetic divergence in *Neurospora*: Comparing methods of species recognition in a model eukaryote. *Evolution* 57: 2721–2741.
- Dettman JR, Jacobson DJ, Taylor JW. 2006. Multilocus sequence data reveal extensive phylogenetic species diversity within the *Neurospora discreta* complex. *Mycologia* 98: 436–446.
- Carbone I, Kohn LM. 1999. A method for designing primer sets for speciation studies in filamentous ascomycetes. *Mycologia* 91: 553–556.
- Geiser DM, Klich MA, Frisvad JC, Peterson SW, Varga J, Samson RA. 2007. The current status of species recognition and identification in *Aspergillus*. *Studies in Mycology* 59: 1–10.

- Granmo A. 1999. Morphotaxonomy and chorology of the genus *Hypoxylon* (Xylariaceae) in Norway. *Sommerfeltia* 26: 1–81.
- Guo LD, Hyde KD, Liew CY. 2000. Identification of endophytic fungi from *Livistona chinensis* based on morphology and rDNA sequences. *New Phytologist* 147: 617–630.
- Huelsenbeck JP, Larget B, Miller RE, Ronquist F. 2002. Potential applications and pitfalls of Bayesian inference of phylogeny. *Systematic Biology* 51: 673–688.
- Hsieh HM, Ju YM, Rogers JD. 2005. Molecular phylogeny of *Hypoxylon* and closely related genera. *Mycologia* 97: 844–865.
- Ireland C, Peekhaus N, Lu P, Sangari R, Zhang A, Masurekar P, An Z. 2008. The tryptophan synthetase gene TRP1 of *Nodulisporium* sp.: molecular characterization and its relation to nodulisporic acid A production. *Applied Microbiology and Biotechnology* 79: 451–459.
- Ju YM, Rogers JD. 1996. A revision of the genus *Hypoxylon*. *Mycologia Memoir* No. 20. St. Paul: APS Press. 365 p.
- Ju YM, Rogers JD. 1999. The Xylariaceae of Taiwan (excluding *Anthosthomella*). *Mycotaxon* 73: 343–440.
- Kausrud H, Stensrud O, Decock C, Shalchian-Tabrizi K, Schumacher T. 2005. Multiple gene genealogies and AFLPs suggest cryptic speciation and long-distance dispersal in the basidiomycete *Serpula himantioides* (Boletales). *Molecular Ecology* 15: 421–431.
- Lee JS, Ko KS, Jung HS. 2000. Phylogenetic analysis of *Xylaria* based on nuclear ribosomal ITS1-5.8S-ITS2 sequences. *FEMS Microbiological Letters* 187: 89–93.
- Mazzaglia A, Anselmi N, Vicario S, Vannini A. 2001. Sequence analysis of the 5.8S rDNA and ITS regions in evaluating genetic relationships among some species of *Hypoxylon* and related genera. *Mycological Research* 105: 670–675.
- Miller AN, Huhndorf SM. 2004. Using phylogenetic species recognition to delimit species boundaries within *Lasiosphaeria*. *Mycologia* 96: 1106–1127.
- Miller JH. 1961. A monograph of the world species of *Hypoxylon*. Univ. Georgia Press. Athens. 158 pp.
- Nylander JA. 2004. MrModeltest v2. Evolutionary Biology Centre, Uppsala University.
- O'Donnell K, Cigelnik E. 1997. Two divergent intragenomic rDNA ITS2 types within a monophyletic lineage of the fungus *Fusarium* are nonorthologous. *Molecular Phylogenetics and Evolution* 7: 103–116.
- Ondeyka JG, Helms GL, Hensen OD, Goetz MA, Zink DL, Tsipouras A, Shoop WL, Slayton L, Dombrowski AW, Polishook JD, Ostlind DA, Tsou NN, Ball RG, Singh SB. 1997. Nodulisporic Acid A, a novel and potent insecticide from a *Nodulisporium* sp. isolation, structure determination and chemical transformations. *Journal of the American Chemical Society* 119: 8809–8816.
- Ondeyka JG, Dahl-Roshak AM, Tkacz JS, Zink DL, Zakson-Aiken M, Shoop WL, Goetz MA, Singh SB. 2002. Nodulisporic Acid B, B1, and B2: A Series of 10-Deoxy-nodulisporic Acids from *Nodulisporium* sp. *Bioorganic and Medicinal Chemistry Letters* 12: 2941–2944.
- Ostlind DA, Felcetto T, Misura A, Ondeyka JG, Smith S, Goetz MA, Shoop WL, Mickle W. 1997. Discovery of a novel indole diterpene using first instars of *Lucilia sericata*. *Medical and Veterinary Entomology* 11: 407–408.
- Peláez F, Platas G, Collado J, Díez MT. 1996. Intraspecific variation in two species of aquatic hyphomycetes, assessed by RAPD analysis. *Mycological Research* 100: 831–837.
- Peláez F, González V, Platas G, Sánchez-Ballesteros J, Rubio V. 2008. Molecular phylogenetic studies within the family Xylariaceae based on ribosomal DNA sequences. *Fungal Diversity* 31: 111–134.

- Petrini LE, Müller E. 1986. Haupt-und Nebenfruchtformen europäischer Hypoxylon-Arten (*Xylariaceae*, *Sphaeriales*) und verwandter Pilze. *Mycologia Helv.* 1(7): 501–627.
- Platas G, Acero J, Borkowski JA, González V, Portal MA, Rubio V, Sánchez-Ballesteros J, Salazar O, Peláez F. 2001. Presence of a simple tandem repeat in the ITS1 region of the *Xylariales*. *Current Microbiology* 43: 43–50.
- Platas G, Polishook JD, Peláez F. 2002. VNTR polymorphism in the ITS1 region (rDNA) in isolates of a *Nodulisporium* species. *Mycological Research* 106: 1293–1298.
- Polishook JD, Ondeyka JG, Dombrowski AW, Peláez F, Platas G, Teran AM. 2001. Biogeography and relatedness of *Nodulisporium* strains producing nodulisporic acid. *Mycologia* 93: 1125–1137.
- Promptuttha I, Jeewon R, Lumyong S, McKenzie EHC, Hyde KD. 2005. Ribosomal DNA fingerprinting in the identification of non sporulating endophytes from *Magnolia liliifera* (*Magnoliaceae*). *Fungal Diversity* 20: 167–186.
- Rogers JD, Callan BE, Samuels GJ. 1987. *Xylariaceae* of the rain forests of North Sulawesi (Indonesia). *Mycotaxon* 29: 113–172.
- Ronquist F, Huelsenbeck JP. 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics* 19: 1572–1574.
- Sánchez-Ballesteros J, González V, Salazar O, Acero J, Portal MA, Julián M, Rubio V, Bills GF, Polishook JD, Platas G, Mochales S, Peláez F. 2000. Phylogenetic study of *Hypoxylon* and related genera based on ribosomal ITS sequences. *Mycologia* 92: 964–977.
- Shoop WL, Gregory LM, Zakson-Aiken M, Michael BF, Haines HW, Ondeyka JG, Meinke PT, Schmatz DM. 2001. Systemic efficacy of nodulisporic acid against fleas on dogs. *Journal of Parasitology* 87: 419–423.
- Singh SB, Ondeyka JG, Jayasuriya H, Zink DL, Ha SN, Dahl-Roshak A, Greene J, Kim JA, Smith MM, Shoop W, Tkacz JS. 2004. Nodulisporic acids D-F: structure, biological activities, and biogenetic relationships. *Journal of Natural Products* 67: 1496–1506.
- Smith AB, Davulcu AH, Cho YS, Ohmoto K, Kürti L, Ishiyama H. 2007. Indole Diterpene Synthetic Studies. Total Synthesis of (+)-Nodulisporic Acid F and Construction of the Heptacyclic Cores of (+)-Nodulisporic Acids A and B and (–)-Nodulisporic Acid D. *Journal of Organic Chemistry* 72: 4596–4610.
- Smith AB, Kürti L, Davulcu AH, Cho YS, Ohmoto K. 2007. Indole Diterpene Synthetic Studies: Development of a Second-Generation Synthetic Strategy for (+)-Nodulisporic Acids A and B. *Journal of Organic Chemistry* 72: 4611–4620.
- Smith AB, Davulcu AH, Kürti L. 2006. Indole diterpenoid synthetic studies. The total synthesis of (+)-nodulisporic acid F. *Organic Letters* 8: 1665–1668.
- Smith AB, Davulcu AH, Kürti L. 2006. Indole diterpenoid synthetic studies. Construction of the heptacyclic core of (–)-nodulisporic acid D. *Organic Letters* 8: 1669–1672.
- Smith MM, Warren VA, Thomas BS, Brochu RM, Ertel EA, Rohrer S, Schaeffer J, Schmatz DM, Petuch BR, Tang YS, Meinke PT, Kaczorowski GJ, Cohen CJ. 2000. Nodulisporic acid opens insect glutamate-gated chloride channels: identification of a new high affinity modulator. *Biochemistry* 39: 5543–5554.
- Stadler M, Wollweber H, Fournier J. 2004. host-specific species of *Hypoxylon* from France, and notes on the chemotaxonomy of the “*Hypoxylon rubiginosum* complex”. *Mycotaxon* 90: 187–211.
- Stadler M, Hellwig V. 2005. Chemotaxonomy of the *Xylariaceae* and remarkable bioactive compounds from *Xylariales* and their associated asexual stages. *Recent Research Development Phytochemistry* 9: 41–93.

- Suwannasai N, Rodtong S, Thienhirun S, Whalley AJS. 2005. New species and phylogenetic relationships of *Hypoxylon* species found in Thailand inferred from the internal transcribed spacer regions of ribosomal DNA sequences. *Mycotaxon* 94: 303–324.
- Taylor JW, Jacobson DJ, Kroken S, Kasuga T, Geiser DM, Hibbett DS, Fisher MC. 2000. Phylogenetic species recognition and species concepts in fungi. *Fungal Genetics and Biology* 31: 21–32.
- Triebel D, Persoh D, Wollweber H, Stadler M. 2005. Phylogenetic relationships among *Daldinia*, *Entonaema* and *Hypoxylon* as inferred from ITS nrDNA analyses of Xylariales. *Nova Hedwigia* 80: 25–43.
- White TJ, Bruns T, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: *PCR Protocols: A guide to methods and applications* (eds. M.A. Innis, D.H. Gelfand, J.J. Sninsky and T.J. White). Academic Press Inc., San Diego, USA: 315–322.

Two new species of *Stachybotrys* from soil

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Abstract — Two new species of *Stachybotrys*, *S. nielamuensis* and *S. zhangmuensis* both from soil in China, are described and illustrated. The type specimens (dried cultures) and living cultures are deposited in the Herbarium of Shandong Agricultural University Plant Pathology (HSAUP). Isotypes are kept in the Herbarium of Institute of Microbiology, Academia Sinica (HMAS).

Key words — taxonomy, soil fungi, dematiaceous hyphomycetes

Introduction

Stachybotrys Corda was erected in 1837, and since then 92 epithets have been proposed in the genus (indexfungorum.org/Names/Names.asp). This genus is characterized by distinct, mononematous conidiophores bearing an apical cluster of several swollen phialides producing unicellular phialoconidia that become aggregated in globose masses. In the course of a survey of soil dematiaceous hyphomycetes in China, several unusual species of *Stachybotrys* were collected. Two of them are described here as new species, *S. nielamuensis* and *S. zhangmuensis*.

Taxonomic descriptions

Stachybotrys nielamuensis Y.M. Wu & T.Y. Zhang, sp. nov.

FIGURE 1

MYCOBANK MB 513142

Coloniae in CMA effusae, atrogriseae vel nigrae. Hyphis ramosis, septatis, laevibus, hyalinis vel subhyalinis, 1.5–2.5 µm crassis. Conidiophora recta vel leviter curvata, 2–6-septata, hyalina, laevia, 200–250 µm longa, ad basim 12–15 µm diam. Phialides 6–8 ad apicem conidiophori productae, hyalinae, laevia, 13–15 × 6–8 µm. Conidia clavata vel oblonga, griseo-brunnea, tuberculata, 11–16 × 6–9 µm.

HOLOTYPE: from forest soil, Nielamu, Tibet, China, altitude 2500 m, 14 Sept. 2007, Y.M. Wu, HSAUPII₀₇1334, **holotype** (HMAS 196254, isotype).

ETYMOLOGY: in reference to the type location.

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FIG. 1 Conidia and conidiophores of *Stachybotrys nielamuensis* (ex holotype; bars = 20 μm).
Left: drawings; right: photomicrographs.

Colonies on CMA (cornmeal agar) at 25°C for 21 days 4–6 cm diam., effuse, darkish grey to black. Mycelium mostly superficial, partly immersed. Hyphae branched, septate, smooth, hyaline to subhyaline, 1.5–2.5 μm wide. Conidiophores straight or slightly curved, unbranched or rarely branched, 2–6-septate, hyaline, smooth, 200–250 μm long, swollen at the basal cell up to 12–15 μm wide. Phialides borne in groups of 6–8 at the apices of conidiophores, hyaline, smooth, 13–15 \times 6–8 μm . Conidia clavate or oblong, obviously tuberculate, 0-septate, greyish brown, 11–16 \times 6–9 μm .

In conidial morphology *Stachybotrys nielamuensis* somewhat resembles *S. kampalensis* Hansf. (Hansford 1943), *S. freycinetiae* McKenzie (McKenzie 1991), and *S. verrucispora* Matsush. (Matsushima 1985). However *S. kampalensis* and *S. freycinetiae* have hyaline to olivaceous conidiophores and smaller conidia (the former 9–13 \times 6–7 μm , the latter 11–13 \times 4–4.5 μm). *S. verrucispora* has pale brown conidiophores and phialides, and shorter but wider (10–15 \times 9.5–11 μm) conidia.

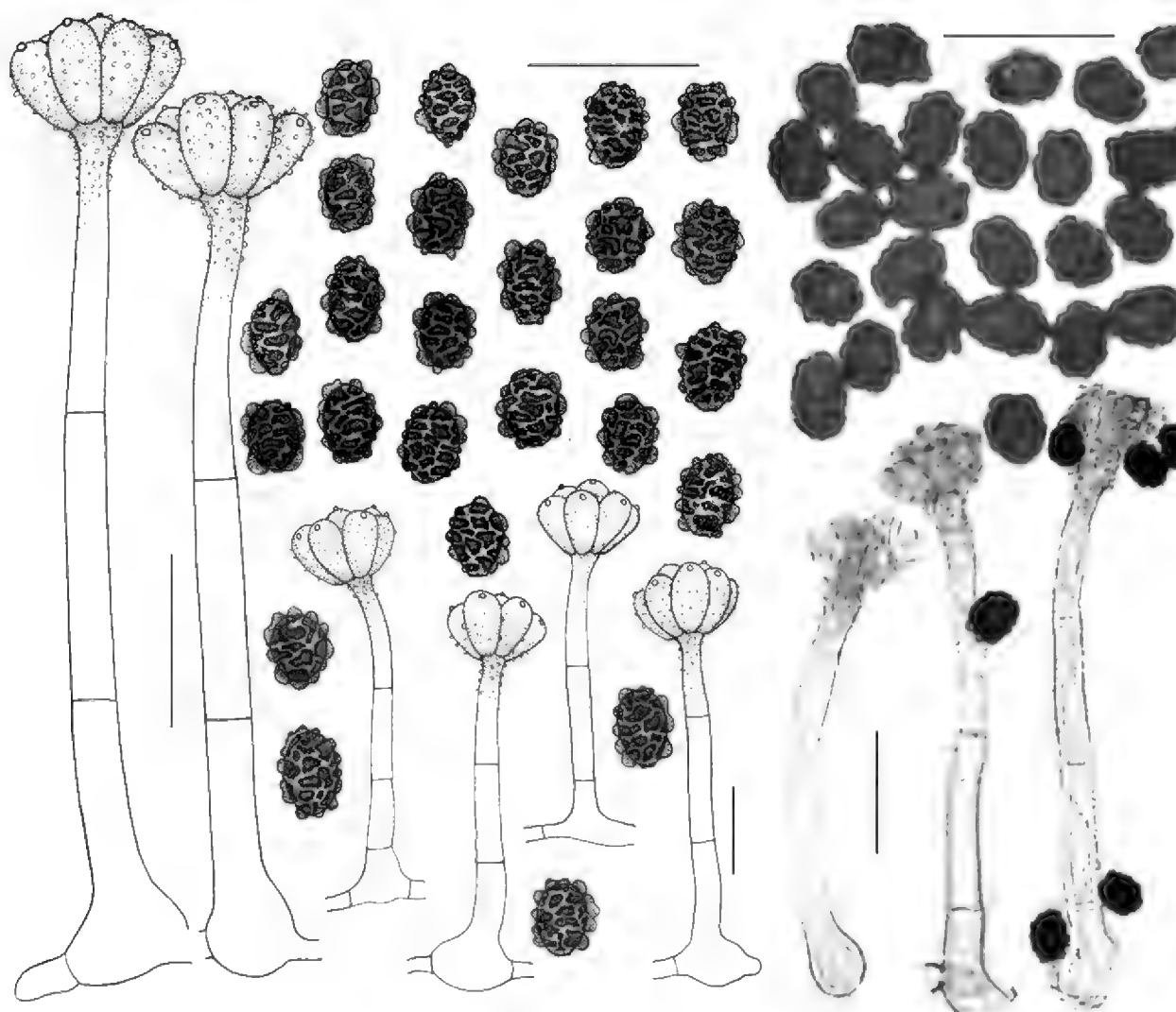


FIG. 2 Conidia and conidiophores of *Stachybotrys zhangmuensis* (ex holotype; bars = 20 μ m).
Left: drawings; right: photomicrographs.

***Stachybotrys zhangmuensis* Y.M. Wu & T.Y. Zhang, sp. nov.**

FIGURE 2

MYCOBANK MB 513147

Coloniae in CMA effusae, atrogriseae vel nigrae. *Hyphis* ramosis, septatis, laevibus, hyalinis vel subhyalinis, 1.5–2 μ m crassis. *Conidiophora* erecta, recta vel leviter curvata, 1–3-septata, basi subhyalina, supra griseo-brunnea, verrucosa, interdum granulistecta, 100–120 μ m longa, ad basim 6–9 μ m diam. *Phialides* 6–7 ad apicem conidiophori productae, olivaceo-griseae, verrucosae, 8–12 \times 5–6 μ m. *Conidia* ovoidea, ellipsoidea, vel oblonga, continua, griseo-brunnea, tuberculata, 8–9.5 \times 6–7 μ m.

HOLOTYPE: from forest soil, Zhangmu, Tibet, China, altitude 2300 m, 11 Sept. 2007, Y.M. Wu, HSAUPII₀₇1346, **holotype** (HMAS 196255, isotype).

ETYMOLOGY: in reference to the type location.

Colonies on CMA at 25°C for 21 days 5–8 cm diam., effuse, darkish grey to black. Mycelium mostly superficial, partly immersed. Hyphae branched, septate, smooth, hyaline to subhyaline, 1.5–2 μ m wide. Conidiophores straight or slightly curved, unbranched or rarely branched, 1–3-septate, subhyaline near the base, greyish brown above, verrucose, covered with large granules, 100–120 μ m long, 6–9 μ m wide near the base. Phialides borne in groups of

6–7 at the apices of conidiophores, pale olive-grey, verrucose, $8\text{--}12 \times 5\text{--}6 \mu\text{m}$. Conidia ovoid, ellipsoid or oblong, tuberculate, 0-septate, greyish brown, $8\text{--}9.5 \times 6\text{--}7 \mu\text{m}$.

Stachybotrys zhangmuensis somewhat resembles *S. chartarum* (Ehrenb.) S. Hughes (Hughes 1958) and *S. microspora* (B.L. Mathur & Sankhla) S.C. Jong & E.E. Davis (Jong & Davis 1976) in conidial colour and size, but *S. zhangmuensis* has more obviously tuberculate conidia, otherwise bigger than *S. microspora* ($6\text{--}8 \times 4\text{--}5 \mu\text{m}$), and wider than *S. chartarum* ($7\text{--}12 \times 4\text{--}6 \mu\text{m}$).

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Literature cited

- Jong SC, Davis EE. 1976. Contribution to the knowledge of *Stachybotrys* and *Memnoniella* in culture. *Mycotaxon* 3: 409–485.
- Hansford CG. 1943. Contribution towards the fungus flora of Uganda. V. Fungi Imperfecti. *Proc. Linn. Soc. London* 155: 34–67.
- Hughes SJ. 1958. Revisiones Hyphomycetum aliquot cum appendice de nominibus rejiciendis. *Can. J. Bot.* 36: 727–836.
- Matsushima T. 1985. Matsushima Mycological Memoirs No. 4. 1–68 + plates.
- McKenzie EHC. 1991. Dematiaceous hyphomycetes on *Freycinetia* (Pandanaeae). 1. *Stachybotrys*. *Mycotaxon* 41: 179–188.

The aphyllophorales (*Basidiomycota*) of a Mediterranean biodiversity “hotspot” — “Cazorla, Segura & Las Villas” Natural Park (Spain)

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Abstract — A preliminary inventory of the aphyllophorales of the “Cazorla, Segura & Las Villas” Natural Park is presented, based on original data augmented by literature references. This catalogue includes 200 species representing 90 genera. Seven species are new to the catalogue of Spanish mycobiota: *Antrodia albidoides*, *Fibricium subceraceum*, *Gloeodontia columbiensis*, *Hyphodermella densa*, *Oliveonia pauxilla*, *Postia undosa*, and *Skeletocutis albocremaea*. The complete catalogue is available on <http://www.mycotaxon.com/resources/weblis.html>.

Key words — mycobiota, corticioid fungi, *Polyporaceae*, fungal diversity, Iberian Peninsula

Introduction

“Hotspots” are areas characterized by exceptional number of endemic species that have suffered an extraordinary habitat loss. Regions with Mediterranean climate (wet winters and dry summers) account for most of the world’s extra-tropical biodiversity hotspots (Myers et al. 2000), being both highly diverse and highly endangered. The biota of these regions is characterized by high diversity, with large numbers of highly localized endemic species (Cowling et al. 1996). The Mediterranean Basin hotspot stretches from Portugal to Jordan and from Morocco to northern Italy.

The “Cazorla, Segura & Las Villas” Natural Park, the largest protected area of Spain and second largest of Europe, was declared a Biosphere Reserve by UNESCO in 1983. Situated in southern Spain and covering an area of 214,300 ha, the Park occupies the Southeast region of Jaén Province (FIG. 1). It is formed

by the Prebético mountain system and oriented SW-NE, with altitudes ranging from 460 to 2109 m. Pico de las Empanadas (2107 m) and Pico Cabañas (2036 m) occupy the highest points and Huesa (460 m), occupies the lowest elevation. The climate is mild Mediterranean, with an 800–2000 mm annual rainfall and temperatures ranging from 30–35°C (summer) to 10–15°C (winter). Its latitudinal and altitude variations combined with its orography greatly influence the Park climate and produce microclimates that make possible the existence of a diversified Mediterranean flora and allow growth of species more typical of northern zones. The floristic richness of this territory can be seen in the high number of endemic species of vascular plants: 27 endemic for the area and more than 130 Iberic endemics.

Below 850 m, we find large areas of holm oak (*Quercus ilex* subsp. *ballota*) with *Phillyrea angustifolia*, *Pistacia lentiscus*, *Rhamnus alaternus*, *Rhamnus lycioides*, *Prunus spinosa*, and *Lonicera implexa*. To a great extent, this forest type has been repopulated with *Pinus halepensis* that continues the evergreen shrub association — *Rosmarinus officinalis*, *Cistus monspeliensis*, *C. clusii*, *C. salviifolius*, *Genista scorpius*, *Halimium atriplicifolium*, *Pistacia lentiscus*, and *Thymus mastichina*.

Between 850–1200 m, woods with (among others) *Quercus ilex* subsp. *ballota*, *Q. faginea*, *Arbutus unedo*, *Phillyrea latifolia*, *Viburnum tinus*, *Erica arborea*, *Sorbus domestica*, *Clematis vitalba*, and *Hedera helix* are present. Between 1200–1500 m, we find *Pinus nigra* forests with *Crataegus monogyna*, *Juniperus phoenicea*, *Berberis hispanica*, *Ilex aquifolium*, *Lonicera splendida*, and *Cytisus reverchonii* also present. From 1500–1800 m, on deep and fertile soils, *Acer granatense*, *Prunus mahaleb*, *Crataegus monogyna*, *Sorbus aria*, *Lonicera arborea*, and *L. etrusca*, occur in small but very interesting forests. Previously abundant, these stands now form mixed formations with *P. nigra*.

Above 1800 m, *P. nigra* groves with *Juniperus communis* subsp. *hemisphaerica*, *J. sabina*, *Prunus prostrata*, *Genista longipes*, and others are found.

Materials and methods

This study is based on original and bibliographical data. The original data result from the study of specimens collected in 14 localities from within the “Cazorla, Segura & Las Villas” Natural Park, 12 during the III Mycological Foray (11–13 May 1990) “Flora Mycologica Iberica” project, with the remaining two localities visited earlier.

A total of 415 specimens were studied following classical methods for the ascomycota fungi: thin, freehand sections from each specimen were mounted in KOH (5%) and/or Melzer’s reagent. These sections were studied under optical microscope. The specimens have been deposited in LISU and MA-Fungi herbaria

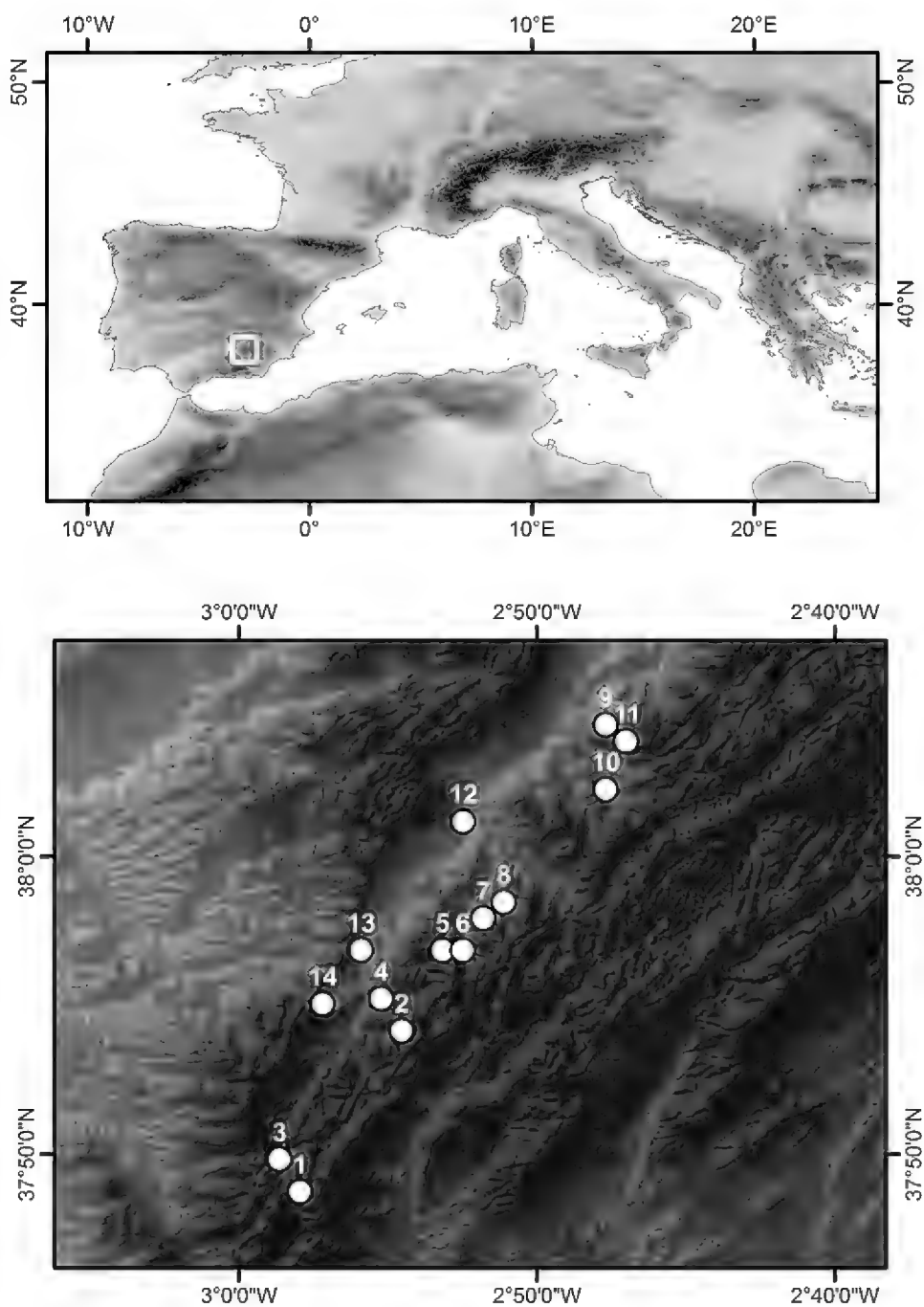


FIG. 1a. Geographical location of the “Cazorla, Segura & Las Villas” Natural Park.
b. Localities sampled.

Results

The catalogue of the aphylophorales from the Natural Park of “Cazorla, Segura and Las Villas, Spain” includes 200 species, of which 97 are new for the Park (<http://www.mycotaxon.com/resources/weblist.html>). They represent 90 genera, the most significant of which are *Peniophora* (12 species), *Phanerochaete* (8 species), *Hyphoderma* (6 species), and *Hyphodontia* (6 species).

Seven species are new to the Spanish mycobiota: *Antrodia albidoides* A. David & Dequatre, with a Mediterranean distribution (Bernicchia 1990); *Fibricium subceraceum* (Hallenb.) Bernicchia, described from Iran (Hallenberg

1978) and later found in Italy and Argentina (Hjortstam & Ryvarden 1986); *Gloeodontia columbiensis* Burt ex Burds. & Lombard; *Hyphodermella densa* Melo & Hjortstam, until now restricted to Portugal (Melo & Hjortstam 2003); *Oliveonia pauxilla* (H.S. Jacks.) Donk, known from northern Europe, Canada, and Puerto Rico (Roberts 1999); *Postia undosa* (Peck) Jülich, widely distributed, but rare in the coniferous forests of the north temperate zone (Ryvarden & Gilbertson 1994), and *Skeletocutis albocrema* A. David.

One remarkable discovery in the park was the collection of *Campylomyces heimii* (Malençon) Nakasone, which Malençon (1939) originally described from Morocco on dry branches of *Quercus ilex* still attached to the tree. Telleria & Dueñas (1986) cited a second record from Cantabria (Spain), and our discovery of *C. heimii* on its typical substrate in Cazorla constitutes a third report.

Hyphoderma multicystidium var. *disporum* (M. Dueñas & Telleria) Hjortstam & Telleria, is reported for the third time. Dueñas & Telleria (1988) previously reported the species (as *Crustoderma sabinicum* var. *disporum* M. Dueñas & Telleria) from León and Guadalajara (Spain), fruiting on juniper wood.

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Literature cited

- Bernicchia A. 1990. *Polyporaceae* s.l. in Italia. Instituto di Patologia Vegetale. Università degli Studi di Bologna
- Cowling RM, Rundell PW, Lamont BB, Arroyo MK, Arianoutsou M. 1996. Plant diversity in Mediterranean-climate regions. *Trends in Ecology and Evolution* 11: 362-366.
- Dueñas M, Telleria MT. 1988. Catálogo de los corticiáceos y poliporáceos, s.l. (*Aphylllophorales*, *Basidiomycotina*) de la micoflora cántabro-astur. *Ruizia* 5: 1-262
- Hallenberg N. 1978. Wood fungi (*Corticiaceae*, *Coniophoraceae*, *Lachnocladiaceae*, *Thelephoraceae*) in N. Iran 1. *Iran Journal Plant Pathology* 14: 38-87.
- Hjortstam K, Ryvarden L. 1986. Some new and noteworthy fungi (*Aphylllophorales*, *Basidiomycetes*) from Iguazu, Argentina. *Mycotaxon* 25: 539-567.
- Malençon G 1939. Champignons rares ou nouveaux du Maroc français. *Bulletin de la Société Mycologique de France* 55: 34-60.
- Melo I, Hjortstam K. 2003. A new species of *Hyphodermella* (*Basidiomycetes*, *Aphylllophorales*) from Portugal. *Nova Hedwigia* 77: 351-355.
- Myers N, Mittermeier RA., Mittermeier CG, Fonseca GAB, Kent J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.
- Roberts P. 1999. *Rhizoctonia*-forming fungi. A taxonomic guide. Royal Botanical Gardens, Kew.
- Ryvarden L, Gilbertson RL. 1994. European polypores. Vols. 2. *Fungiflora*, Oslo.
- Telleria MT, Dueñas M. 1986. De *Aphylllophoralibus* in Hispania provenientibus ordinati comentarii IV. *Anales del Jardín Botánico de Madrid* 43: 3-7.

The North American *Leucopaxillus monticola* (*L. cerealis* complex) newly recorded from Italy

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Abstract — Collections of an interesting small whitish *Leucopaxillus*, found in Italian *Larix* forests, are described and illustrated. This taxon, well characterized by a small pileus with a sulcate margin, a polypore-like odour, and abundant filamentous cheilocystidia, is here described as a minor aberrant form of *L. monticola*. A discussion on its taxonomic position within *Leucopaxillus* and notes on closely related species are also added.

Key words — *Agaricales*, tricholomatoid clade, *Tricholomataceae*, taxonomy

Introduction

According to recent molecular studies, the genus *Leucopaxillus* Boursier clusters in the tricholomatoid clade sensu Matheny, where together with *Clitocybe* (Fr.) Staude, *Collybia* (Fr.) Staude, *Lepista* (Fr.) W.G. Sm., and *Tricholoma* (Fr.) Staude it forms the family *Tricholomataceae* s.s. (Moncalvo et al. 2002, Matheny et al. 2006). Within this genus, the complex of *L. cerealis* (Lasch) Singer 1962 [(= *L. albissimus* (Peck) Singer 1939 s.l., fide Singer 1986)] includes numerous taxa exhibiting whitish basidiomata that are often difficult to circumscribe because they have been recognized based mainly on basidioma stature, organoleptic features (context taste and odour), and subtle variations in microanatomy (i.e., pileipellis structure, spore morphology and ornamentations, degree of the amyloid reaction, presence or absence of cheilocystidia). Given the lack of evidence from sequence data, it is presently difficult to make an informed choice between a splitting attitude, i.e. recognizing a number of micro-species (e.g. Bon 1991, Gulden 1992, Consiglio & Contu 2000) and a lumping one, i.e. regarding them as phenotypic variants of a single species (e.g. Singer & Smith 1943, Malençon & Bertault 1975, Ludwig 2001, Horak 2005, Bresinsky 2006, Christensen 2008). However, based on literature data and our personal

experience, we think that some taxa belonging in this complex are well delimited (e.g. *L. barbarus* (Maire) Kühner 1926, *L. paradoxus* (Costantin & L.M. Dufour) Boursier 1925).

While collecting fungal samples to study the biodiversity of the mycota of Val di Susa (Turin, Italy), we encountered three different collections of specimens of a small, white *Leucopaxillus* that proved difficult to identify to species. A search of the relevant literature (e.g. Singer & Smith 1943, 1948; Bon 1991, Noordeloos 1995) led us to assign the specimens to a form of *L. monticola*, a species described from North America under *Pinus ponderosa* Douglas ex C. Lawson (Singer & Smith 1948) and only recently reported also from Europe (France, Bon 1991). The aim of this paper is to provide a complete description of this rarely collected species along with a discussion on its closest allies, and to extend its geographic and host ranges.

Materials and methods

Macroscopic characters were examined on fresh material. The study of microanatomical features was carried out on dried material using a Leica DM 4500 B and an Olympus BX50 light microscope with magnifications up to 1000 x. Mounts were observed in 3% KOH, Congo red (10% ammonia solution) and Melzer's reagent. Measurements are based on the observation of 30 basidiospores from three basidiomata (apiculus not included). The following abbreviations were used: [X, Y, Z] indicating that measurements were made on X spores, in Y samples from Z collections; Q = the quotient of length and width of the spores; Qm = the mean value of Q values in all collections studied. All the material examined is preserved in TO (Erbario del Dipartimento di Biologia Vegetale, Università degli Studi di Torino, Italia). Herbarium abbreviations follow Holmgren & Holmgren (1998).

Taxonomy

Leucopaxillus monticola (Singer & A.H. Sm.) Bon, Doc. Mycol. 20(79): 58 (1990)

= *Leucopaxillus albissimus* var. *monticola* Singer & A.H.

Sm., Mycologia 39: 730 (1948, "1947").

SELECTED DESCRIPTIONS: Singer & Smith (1948: 730-732); Bon (1991: 109-110).

HABIT collybioid or ± clitocyboid (FIG. 1). PILEUS (20–)25–40(–45) mm in diameter, convex, then applanate, with margin persistently involute, at first almost snow white (reminiscent of a *Clitocybe* sect. *Candicantes*) then with light ochraceous-yellow flushes, or spots, especially at disc, surface at first glazed, finely pruinose, then granulose, slightly cracked, finely ribbed at margin (like *Leucopaxillus amarus* (Alb. & Schwein.) Kühner 1928 or *Tricholoma fulvum* (Bull.) Bigeard & H. Guill. 1909). LAMELLAE fairly crowded, 5–6 mm broad,



FIGURE 1. *Leucopaxillus monticola*. Basidiomes. Scale bar = 10 mm.

with 1(–2) lamellulae between two contiguous lamellae, adnate to subdecurrent, horizontal, non-anastomosing, often with a thin, long tooth on the stipe, whitish, then with a pale yellowish-cream tinge. STIPE (10–)15–25(–30) \times 5–8 mm, white, generally shorter than the pileus diameter, cylindrical, sometimes flaring in the upper part, solid, pruinose at apex, with abundant basal mycelium incorporating substrate particles and whitish rhizomorphs. CONTEXT up to 5–6 mm thick in the pileus, whitish, fragile in the pileus, with a pungent, aromatic odour, a mixture between *Tricholoma saponaceum* (Fr.) P. Kumm. 1871 and *T. sulphureum* (Bull.) P. Kumm. 1871, calling to mind also that of *Heterobasidion annosum* (Fr.) Bref. 1888 s.l. and *Fomitopsis pinicola* (Sw.) P. Karst. 1881, and a slightly bitterish aftertaste on chewing. SPORE PRINT white.

SPORES [30, 3, 3], regularly ellipsoid, (6.5–)7–8 \times 4.5–5.2(–5.8) μm , on average 7.64 \times 4.91 μm , $Q = (1.3\text{--})1.4\text{--}1.7(\text{--}1.9)$, $Q_m = 1.57$, hyaline, generally with an oil droplet, with an amyloid ornamentation of small scattered warts, but at times appearing smooth or almost smooth (FIG. 2a). BASIDIA (26–)30–40(–45) \times 8–10(–12) μm , four-spored, clavate, clamped (FIG. 2b). CHEILOCYSTIDIA (marginal cells) very abundant, colourless, 28–50 \times 2–3(–5) μm , cylindrical, subclavate, fusiform, often nodulose or forked, occasionally multiseptate (FIG. 2c). PILEIPELLIS a cutis of cylindrical hyphae, obscurely erect towards the centre, 4–10 μm wide, with epiparietal pigment. HYMENOPHORAL TRAMA regular, some hyphae with refractive content (thromboplerous hyphae). CLAMP CONNECTIONS numerous.

HABITAT: gregarious to subcaespitose, on *Larix decidua* Mill. litter, often together with *Leucopaxillus amarus*.

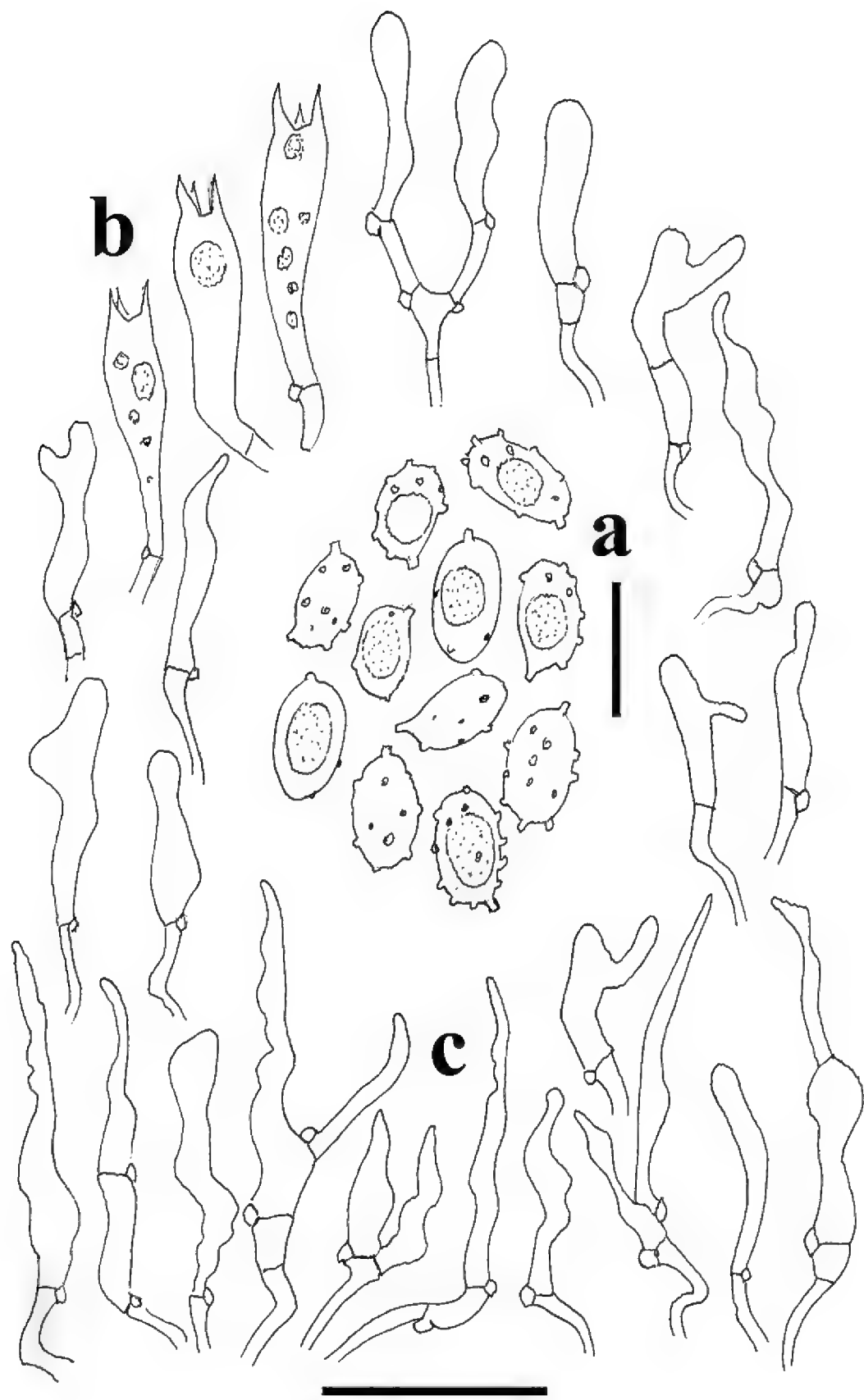


FIGURE 2. *Leucopaxillus monticola*. Micromorphologic characters of the basidiomes
a. Spores. b. Basidia. c. Cheilocystidia. Scale bars: a,b = 10 μ m; c = 30 μ m.

COLLECTION EXAMINED — ITALY, Le Toggie, Parco Orsiera Rocciavré (Mattie, Turin), in a larch wood, 1600 m above sea level (a.s.l.), Sept. 20, 2008, leg. A. Vizzini (TO-HG1152); Bardonecchia (Turin), in a larch wood, 1312 m a.s.l., Sept. 10, 2001, leg. A. Vizzini (TO-HG1151); Colle del Fraiss (Chiomonte, Turin), in a mixed wood of larch and silver fir, 1500 m a.s.l., Sept. 3, 1999, leg. A. Vizzini (TO-HG1150).

Discussion

The micromorphological characters of these specimens, along with most of the macromorphological features, persuaded us to regard these collections as representing a peculiarly thin form of *Leucopaxillus monticola*. *Leucopaxillus monticola* is an American taxon originally proposed by Singer & Smith (1948) as a variety of *L. albissimus*. *Leucopaxillus albissimus* is now considered a synonym of *L. cerealis* (Singer 1986). *Leucopaxillus monticola* was subsequently rediscovered in Europe (France) also by Bon, who raised it to specific rank (Bon 1990). Our collections represent the third report of this taxon on world basis.

The similarities between the American and European collections – which we consider indisputably contaxic, with the consequence that the protologue by Singer & Smith (1948) is to be complemented with the description by Bon (1990) – are numerous as shown below.

1) From a macromorphological point of view, our fungus has (i) a dry, glabrous, opaque pileal surface, which later becomes areolate-rimose; (ii) colours white at margin and brownish-cream at disc; (iii) crowded, arcuate-subdecurrent lamellae; (iv) a clavate stipe, with fibrillose surface and abundant basal mycelium trapping a remarkable quantity of substrate; (v) a tough context with an aromatic odour tending to become disagreeable (like that of *Tricholoma album* (Schaeff.) P. Kumm. 1871 or *T. sulphureum*), with age, and taste that is initially sweetish or non-distinctive and with only a faint bitterish aftertaste.

2) From a micromorphological point of view, it shares with *L. monticola* (i) broadly ellipsoid spores not exceeding 8 µm in length and with an ornamentation that is hardly prominent or even barely visible in several spores [significantly, in the protologue of *Leucopaxillus albissimus* var. *monticola*, Singer & Smith (1948:130) wrote, “Spores 6.5–8 × 4.5–5 µm, broadly ellipsoid, strongly amyloid with small scattered warts (at times appearing almost smooth)”]; (ii) marginal cells abundant and variable in size and shape, at times even lobate (see Bon 1990: 110, who describes them, precisely, as “parfois atténueés à +/- lobés”); (iii) a pileipellis with confusedly erect hyphae.

Our specimens agree fairly well with the original description (Singer & Smith 1948) and with the French collection (Bon 1990, 1991) except for macroscopic and organoleptic features such as the distinctly smaller size, the ribbed margin of the pileus, adnate-subdecurrent lamellae, and smell with an unpleasant sulphureous component right from the start. We believe that these

discrepancies are not significant enough to suggest creating a new taxon at any rank and, in our opinion, they may mirror the intraspecific variability. To date this form seems to be known with certainty only from Italy, but probably present also in France (see René Chéreau's photograph as *L. cutedfractus*, http://www.amo-nantes.com/galerie_de_photos_551.htm).

Leucopaxillus cutedfractus Noordel. (Noordeloos 1984, 1995; = *L. paradoxus* sensu auct. neerl.; = *Leucopaxillus albissimus* var. *cutedfractus* (Noordel.) E. Ludw. 2001), described on the basis of Dutch collections, most likely only an infraspecific variant of *L. paradoxus*, from which it is separated by the occurrence of distinct marginal cells, is a taxon very close to *L. monticola*. *L. cutedfractus* has subsequently been collected in France (Courtecuisse 1993), Spain (Esteve-Raventós et al. 1995), Italy (e.g. Consiglio & Contu 2000, Brizzi 2007), Germany (Ludwig 2001, as *L. albissimus* var. *cutedfractus*), Esthonia (Bresinsky 2006), Finland and Sweden (Christensen 2008). In any case, whatever its taxonomic rank, the latter differs from our fungus in the larger size of basidiomata (pileus 80–120 mm in diameter), the lamellae distinctly less crowded, more decurrent, much thicker and strongly anastomosing at the stipe insertion, as well as the broader spores (4.5–6.0(–6.5) μm) with a distinctly more prominent ornamentation; in addition, the context is odourless or its odour is just aromatic, not unpleasant, and the taste sweetish, certainly neither bitter nor disagreeable, and the habitat is different (tendency to grow on sandy, ruderal sites, under broadleaf trees).

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Literature cited

- Bon M. 1990. Taxons nouveaux et validations. Doc. Mycol. 20(79): 57–62.
- Bon M. 1991. *Tricholomataceae* (Fayod) Heim (1ère partie) (*Tricholomoideae* et *Leucopaxilloideae*). *Flore Mycologique d'Europe* Vol. 2. Les Tricholomes et Ressemblants. Doc. Mycol. Mémoire Hors Série. Amiens, 163 p.
- Bresinsky A. 2006. Observations on mycobiota in Estonia. *Folia Cryptogamica Estonica* 42: 1–9.
- Brizzi B. 2007. *Leucopaxillus cutedfractus*. Bollettino del Gruppo Micologico Camaioresse 15: 50–54.
- Christensen M. 2008. *Leucopaxillus* Boursier. In: Knudsen H, Vesterholt J (eds), *Funga Nordica*. Nordsvamp, Copenhagen, pp. 409–411.
- Consiglio G, Contu M. 2000. Il genere *Leucopaxillus* Boursier in Italia, con brevi note sulle rimanenti specie europee. Bollettino della Associazione Micologica Ecologica Romana 51: 3–36.

- Courtecuisse R. 1993. Macromycètes intéressants, rares ou nouveaux VII. Taxons nouveaux pour la France et autres récoltes remarquables. Doc. Mycol. 23(91): 1–12.
- Esteve-Raventós F, González V, Moreno G, Arenal F. 1995. Due specie rare di *Leucopaxillus*, *L. cutedractus* e *L. lepidoides* rinvenute in Spagna. Rivista di Micologia 38 (3): 273–278.
- Gulden G. 1992. *Leucopaxillus* Bours. In: Hansen L, Knudsen H (eds), Nordic Macromycetes Vol. 2. Nordsvamp, Copenhagen, pp. 135–136.
- Holmgren PK, Holmgren NH. 1998. (continuously updated). Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/> (accessed 14 May. 2009).
- Horak E. 2005. Röhrlinge und Blätterpilze in Europa. Spektrum, Elsevier, Heidelberg, 592 p.
- Ludwig E. 2001. Die kleinen Gattungen der Makromyzeten mit lamelligem Hymenophor aus den Ordnungen *Agaricales*, *Boletales* und *Polyporales*. Pilzkompendium, Band 1, Beschreibungen. IHW-Verlag, Eching, 758 p.
- Malençon G, Bertault R. 1975. Flore des Champignons supérieurs du Maroc. Tome II. Rabat, 540 p.
- Matheny PB, Curtis JM, Hofstetter V, Aime MC, Moncalvo J-M, Ge Z-W, Yang Z-L, Slot JC, Ammirati JF, Baroni TJ, Bougher NL, Hughes KW, Lodge DJ, Kerrigan RW, Seidl MT, Aanen DK, DeNitis M, Daniele GM, Desjardin DE, Kropp BR, Norvell LL, Parker A, Vellinga EC, Vilgalys R, Hibbett DS. 2006. Major clades of *Agaricales*: a multilocus phylogenetic overview. Mycologia 98: 982–995.
- Moncalvo JM, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Clemençon H, Miller OK. 2002. One hundred and seventeen clades of euagarics. Mol. Phylogenet. Evol. 23 (3): 357–400.
- Noordeloos ME. 1984. Notulae ad Floram Agaricinam Neerlandicam. IV–V. *Clitopilus* and *Leucopaxillus*. Persoonia 12(2): 155–167.
- Noordeloos EM. 1995. *Leucopaxillus*. In: Bas C, Kuyper ThW, Noordeloos ME, Vellinga EC (eds), Flora Agaricina Neerlandica, vol. 3. Balkema, Rotterdam, pp. 76–77.
- Singer R. 1986. The Agaricales in Modern Taxonomy, 4^o ed. Koeltz Scientific Books, Koenigstein, 981 p.
- Singer R, Smith AH. 1943. A monograph on the genus *Leucopaxillus* Boursier. Papers of the Michigan Academy of Science, Arts & Letters 28: 85–132.
- Singer R, Smith AH. 1948 (“1947”). Additional notes on the genus *Leucopaxillus*. Mycologia 39: 725–736.

Two new species of *Septobasidium* (Septobasidiaceae) from China

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Abstract — Two new species, *Septobasidium ardisiae* on *Ardisia* sp. associated with *Pseudaulacaspis* sp. and *Septobasidium pruni* on *Prunus salicina* associated with *Pseudaulacaspis* sp., are described. They were collected from Yunnan Province, China.

Key words — *Pucciniomycetes*, *Septobasidiales*, taxonomy

Previously, 15 species of *Septobasidium* have been reported in China (Sawada 1931, 1933, Couch 1938, Teng 1963, Tai 1979, Kirschner & Chen 2007, Lu & Guo 2009).

During our recent survey of fungal flora in China, two new *Septobasidium* species were found in Yunnan Province, bringing the total *Septobasidium* species recorded for China to 17.

The first undescribed *Septobasidium* species on *Ardisia* sp., associated with a scale insect, *Pseudaulacaspis* sp. (*Diaspididae*), was discovered from Gaoligong Mountains in September 2008. The Gaoligong Mountains lie along the border between southwestern China and Northern Burma. Special ecological and micro-environmental diversity have resulted in an exceptionally rich flora characterized by high species endemism; during the past year the senior author and her colleagues have collected many *Septobasidium* specimens from this area, which has been identified as a global biodiversity “hot spot.”

***Septobasidium ardisiae* C.X. Lu & L. Guo, sp. nov.**

FIGS. 1, 3–5

MYCOBANK MB 513512

Basidioma resupinatum, perenne, 5–10 × 2.5–5 cm, cinnamomeo-brunneum vel brunneum, margine determinatum; superficie laeve, maturitate rimosum separabileque,

*corresponding author

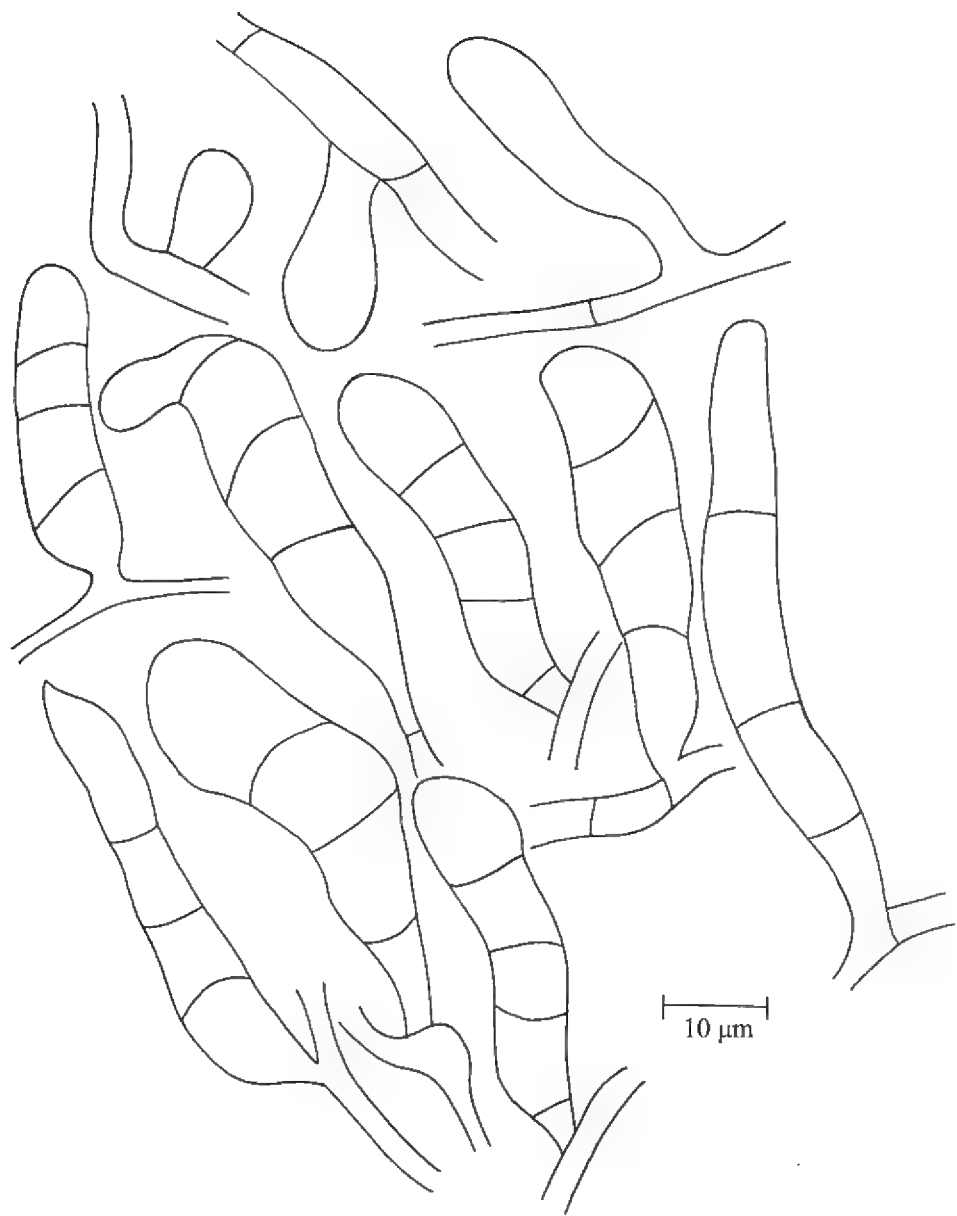


FIG. 1. Basidia of *Septobasidium ardisiae* (HMAS 196432, holotype).

in sectione 630–1150 μm μm crassum, e partibus tribus compositum: 1) subiculum 50–75 μm crassum; 2) pars columnae usque ad 100–245 μm longa; 3) hymenium 215–390 μm crassum, unistratosum vel 2–3-stratosum; basidia cylindrica, recta vel leviter curvata, 4-cellularia, 42–60 × 10–12.5 μm, hyalina vel flavido-brunneola.

TYPE: On *Ardisia* sp. (*Myrsinaceae*): China, Yunnan, Gaoligong Mountains, Longling, alt. 1100 m, 6.IX.2008, S.H. He, Y.F. Zhu & L. Guo 2381, HMAS 196432 (holotype), associated with *Pseudaulacaspis* sp. (*Diaspididae*).

Basidioma on branches, resupinate, perennial, 5–10 × 2.5–5 cm, cinnamon brown or brown; margin determinate; surface smooth, becoming cracked. In section 630–1150 μm thick, composed of three layers: (1) a subiculum, 50–75 μm thick, (2) a region of pillars; pillars 100–245 μm long, 50–150 μm thick,

branched outwards at the top; hyphae of pillars 3–5 µm thick, (3) hymenial layer 215–390 µm thick, single or 2–3-stratose, stratified by the formation of a new hymenium layer over the older one, with closely packed parallel upright threads. Basidia at first pyriform or subglobose, arising directly from the hyphae without a probasidial cell; cylindrical, straight or slightly curved, 4-celled, 42–60 × 10–12.5 µm, hyaline or pale yellowish brown. Haustoria consisting of both irregularly coiled hyphae and spherical cells. Basidiospores not seen.

REMARKS: *Septobasidium ardisiae* is similar to *S. henningsii* Pat. but differs in producing a thinner section (630–1150 µm), shorter pillars (100–245 µm), and a surface soon cracked by 5–10 mm wide fissures. In *S. henningsii* the sections are 1–2 mm thick, the pillars are 300–1100 µm high, and the surface is cracked with smaller (0.1–0.8 mm wide) fissures. In addition, the new species has haustoria in the form of both irregular coiled hyphae and spherical cells, whereas *S. henningsii* has only irregular coiled hyphae.

Couch (1938) regarded *Septobasidium henningsii* as close to *S. albidum* Pat. and *S. flavobrunneum* Boedijn & B.A. Steinm. The new species differs from *S. albidum* and *S. flavobrunneum* mainly in producing stratified hymenia and thicker basidiomata. *Septobasidium albidum* and *S. flavobrunneum* have a single hymenium and thinner sections, measuring 270–370 µm and 270–750 µm respectively.

The second undescribed *Septobasidium* species on *Prunus salicina*, also associated with a scale insect (*Pseudaulacaspis* sp.) is described below.

***Septobasidium pruni* C.X. Lu & L. Guo, sp. nov.**

FIGS. 2, 6–8

MYCOBANK MB 513513

Basidioma resupinatum, 5–10 × 1–2 cm, fumoso-brunneum vel dilutum cinnamomeo-brunneum, margine determinatum; superficie laeve, in sectione 170–330 µm crassum, e partibus tribus indistincte compositum: 1) subiculum 12–22 µm crassum; 2) pars columnae usque ad 50–110 longa, 40–140 µm crassa vel hyphis laxae completa, hyphae partis columnae 3–5 µm crassum; 3) atypicum hymenium 170–200 µm crassum; sine probasidio, basidia cylindrica, recta vel leviter curvata, 4-cellularia, 17–32 × 5–7.5 µm, hyalina vel brunnea.

TYPE: On *Prunus salicina* Lindl. (Rosaceae): China, Yunnan, Kunming, alt. 1920 m, IX.1982, Z.Y. Zhang & Y.X. Wang, HMAS 91283 (**holotype**), associated with *Pseudaulacaspis* sp. (Diaspididae).

Basidioma on branches, resupinate, 5–10 × 1–2 cm, smoke brown or pale cinnamon brown; margin determinate; surface smooth. In section 170–330 µm thick. Indistinctly divided into three regions: (1) a subiculum, 12–22 µm thick, (2) pillars 50–110 µm long, 40–140 µm thick or loosely filled with hyphae; hyphae of pillars 3–5 µm thick, (3) atypical hymenium layer 170–200 µm thick. Basidia arising directly from the hyphae without a probasidial cell; cylindrical,

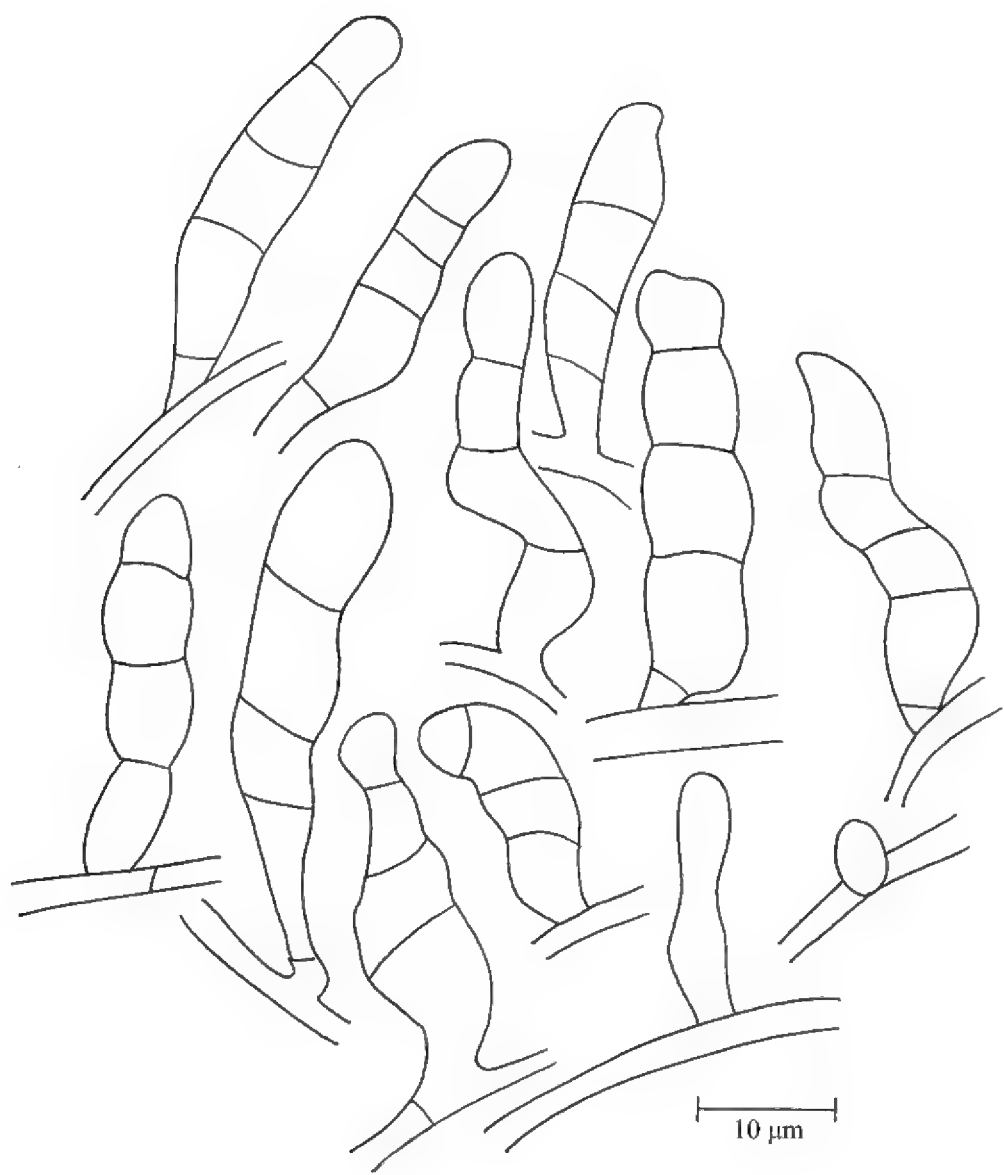
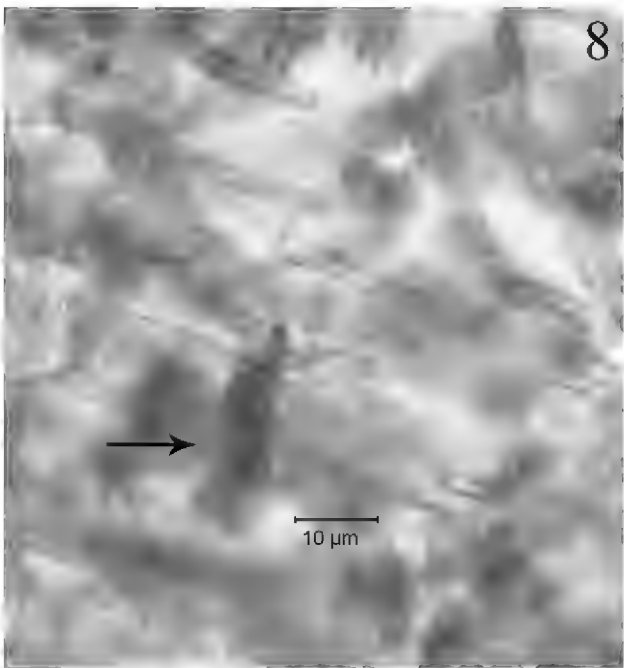
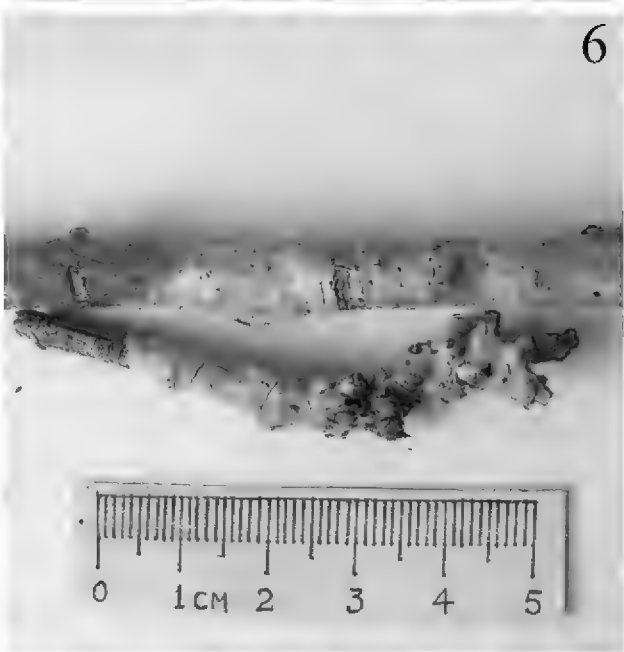
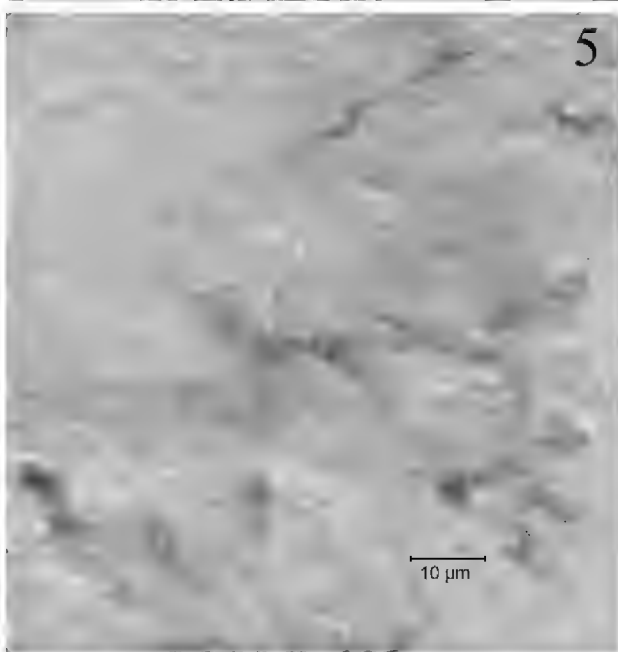
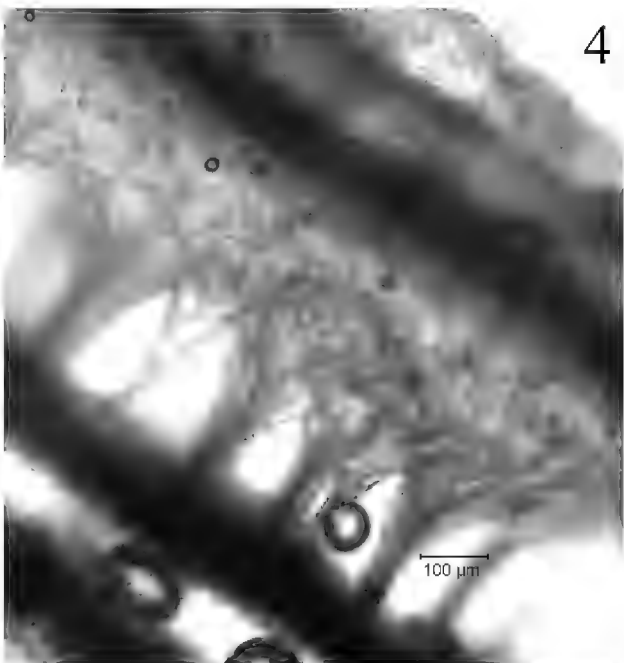
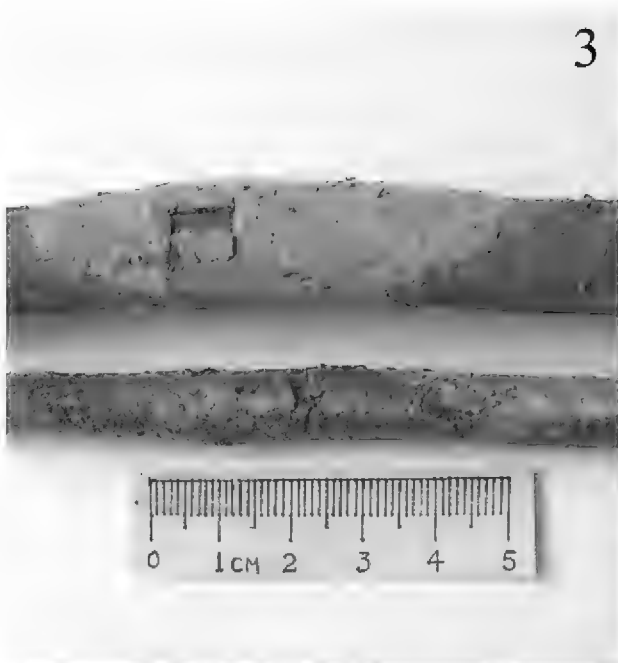


FIG. 2. Basidia of *Septobasidium pruni* (HMAS 91283, holotype).

straight or slightly curved, 4-celled, $17\text{--}32 \times 5\text{--}7.5 \mu\text{m}$, hyaline or brown. Haustoria consisting of irregularly coiled hyphae. Basidiospores not seen.

REMARKS: *Septobasidium pruni* is similar to *S. cirratum* Burt. but differs distinctly in having a thinner ($170\text{--}330 \mu\text{m}$) section, smaller ($17\text{--}32 \times 5\text{--}7.5 \mu\text{m}$) basidia, and lacking a probasidial cell. *Septobasidium cirratum* has sections that are $1\text{--}1.5 \text{ mm}$ thick and basidia measuring $40\text{--}45 \times 8\text{--}8.6 \mu\text{m}$, and with a probasidial cell.

FIGS. 3–5 (right). *Septobasidium ardisiae* (HMAS 196432, holotype). 3. Basidiomata on branches. 4. Section of basidioma. 5. Basidia. FIGS. 6–8. *Septobasidium pruni* (HMAS 91283, holotype). 6. Basidiomata on branches. 7. Section of basidioma. 8. A basidium (arrow).



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Literature cited

- Couch JN. 1938. The Genus *Septobasidium*. Univ. of North Carolina Press, Chapel Hill. 480 p.
- Kirschner R, Chen CJ. 2007. New reports of two hypophyllous *Septobasidium* species from Taiwan. *Fung. Sci.* 22(1,2): 39–46.
- Lu CX, Guo L. 2009. *Septobasidium maesae* sp. nov. (*Septobasidiaceae*) from China. *Mycotaxon* 109: 103–106.
- Sawada K. 1931. Descriptive catalogue of the Formosan fungi. Part V. Rep. Dept. Agric. Govt. Res. Inst. Formosa. 51: 1–131.
- Sawada K. 1933. Descriptive catalogue of the Formosan fungi. Part VI. Rep. Dept. Agric. Govt. Res. Inst. Formosa. 61: 1–99.
- Tai FL. 1979. *Sylloge Fungorum Sinicorum*. Science Press, Beijing. 1527 p.
- Teng SC. 1963. *Fungi of China*. Science Press, Beijing. 808 p.

***Racocetra intraornata*, a new species in the *Glomeromycetes* with a unique spore wall structure**

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Abstract— A new species of the arbuscular mycorrhiza forming *Glomeromycetes*, with distinct ornamentations on the inner surface of the outer spore wall, is here presented under the epithet *Racocetra intraornata*. It was found in the Caatinga, a semi-arid biome of Northeastern (NE) Brazil, and also isolated from a sand dune ecosystem along the semi-humid Atlantic coast of NE Brazil. The species forms yellow to yellow-orange glomerospores, 150–280 µm in diameter, with a three-layered outer wall and a three-layered inner wall. The inner surface of the outer wall is densely crowded with small tubes that resemble germination warts characteristic of *Gigaspora*. The hyaline to rarely light yellow germination shield has 4–6 lobes and may form 4–6 germ tube initiations. The species can easily be distinguished from all other species in the *Racocetraceae* by the unique outer wall ornamentation.

Key words — *Glomeromycota*, *Gigasporineae*, *Gigasporaceae*, *Scutellospora*

Introduction

During studies on the diversity of arbuscular mycorrhizal fungi (AMF) in natural ecosystems of Northeastern Brazil, a new species of the *Gigasporineae* sensu Morton & Benny (1990) was found that forms bi-walled spores on sporogenous cells and a discrete, multiply lobed, hyaline to subhyaline germination shield on the inner spore wall. Species with such characteristics were recently excluded from the revised genus *Scutellospora* and re-organized in the new genus *Racocetra* of the new family *Racocetraceae* (Oehl et al. 2009). The new species has a diagnostic ornamentation on the inner surface of the outer spore wall and is hereafter described under the epithet *Racocetra intraornata*.

Material and methods

Soil sampling and culturing of AM fungi

Soils were sampled in the semi-arid Caatinga biome in the National Park of 'Vale do Catimbau' (Municipality of Buíque), Pernambuco State, and in a sand dune ecosystem in Mataraca, Paraíba State, both in Northeast Brazil. The samples were taken from the rhizosphere (0–20 cm depth) of typical native plants in January 2006 (Buíque) and September 2007 (Mataraca).

The site in Buíque (about 700 m altitude) is situated at 08°32'54"S and 37°14'50"W, and the soil is characterized by 0.7–1.1 % organic matter, pH (H₂O) of 5.4 and 7 mg kg⁻¹ available P (extracted after Mehlich; Nelson et al. 1953). The climate is semi-arid hot (type Bsh of Köppen) with a dry summer, high (30–40°C) daytime temperatures and lower (15°C) nighttime temperatures (<http://prefeituradebuie.com>); the mean annual precipitation is 610 mm. In this semi-arid area, Caatinga vegetation is represented by species of *Euphorbiaceae*, *Caesalpinaceae*, *Malpighiaceae*, *Myrtaceae*, *Mimosaceae*, *Fabaceae*, and *Cactaceae* (e.g. *Cnidocolus obtusifolius* Pohl, *Caesalpinia microphylla* Mart., *Byrsonima gardneriana* A. Juss., *Eugenia biflora* (L.) Dc., *Acacia bahiensis* Benth., *Bocoa mollis* (Benth.) Cova, and *Pilosocereus tuberculatus* (Werdermann) Byles & Rowley), among others (Gomes et al. 2006).

The site in Mataraca, at 14 m altitude, is located at 06°30'00"S and 34°57'10"W, and the soil characterized by 0.7–1.1 % organic matter, pH (H₂O) of 5.5–5.8; 3–7 mg kg⁻¹ P. The climate is tropical rainy (type Am of Köppen), with a short dry period of four months. The mean annual temperature is 25.5°C, and the mean annual precipitation is 1.795 mm. In the sand dune ecosystem, the vegetation is typical of 'restinga', with physiognomy varying from tree-shrub to herbaceous plants (Oliveira-Filho & Carvalho 1993). Restingas are sandy coastal plains that stand between the coastal primary sand dunes and the Brazilian Atlantic forest and thus have several plant species of both neighboring ecosystems in common. They consist of species from various families such as *Anacardiaceae*, *Annonaceae*, *Bignoniaceae*, *Caesalpinaceae*, *Lauraceae*, *Myrtaceae*, *Rhamnaceae*, *Rubiaceae*, and *Sterculiaceae* (e.g. *Anacardium occidentale* L., *Caesalpinia echinata* Lam., *Eugenia kunthiana* (Kunth) Dc., *Guazuma ulmifolia* Lam., *Ocotea gardneri* (Meisn.) Mez, *Tabebuia roseoalba* (Ridl.) Sandwith, *Tapirira guianensis* Aubl., *Tocoyena selleana* Schum., *Xylopia nitida* Dunnal., and *Ziziphus joazeiro* Mart.) (Souza 2008).

The native AMF communities were cultured with *Sorghum bicolor* in 500 mL pots, filled with autoclaved sand-vermiculite substrate (1:1; w/w; 400 g per pot) mixed with the natural field soil as AMF inoculum (50 g per pot), at the greenhouse of the Department of Mycology, Universidade Federal de Pernambuco, Recife. Additionally, multiple glomerospores of the species were separated and used as infective propagules in single species cultures on *S. bicolor* (L.) Moench. The new species has not yet been propagated successfully in bait cultures or single species cultures.

Morphological analyses

Glomerospores were extracted from field soil samples and bait culture substrates by wet sieving (Gerdemann & Nicolson 1963) and sucrose centrifugation (Jenkins 1964). The spores were thereafter mounted in PVLG, PVLG + Melzer's reagent and in water,

respectively (Brundrett et al. 1994). About 100 spores were examined. In the species description, terminology followed Oehl et al. (2006), Sieverding & Oehl (2006), and Palenzuela et al. (2008) for species in the *Diversisporales* and Walker & Sanders (1986) and Oehl et al. (2009) for germination shield structures. The terminology proposed by Goto & Maia (2006) was adopted for the spore denomination.

Description of the new species

Racocetra intraornata B.T. Goto & Oehl, sp. nov.

FIGS. 1–12

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Sporocarpia ignota. Sporae singillatim in solo efformatae anguste adiacetae ad cellulas sporogeneas subterminales vel intercalares, flavae ad flavo-aurantiae, globosae (150–260 μm in diametro) vel subglobosae (145–250 \times 165–280 μm); sporae cum tunicis duabus: tunica exterior stratis tribus, in totum (7.5–)9–14(–18) μm crassa, coniuncta tunicam cellulae sporogeneae et tunica hyphae; stratum exterius tunicae exterioris hyalinum, (semi-)persistens, 1.1–2.1 μm crassum; stratum medium laminatum, flavum ad flavo-aurantium, 7.5–14 μm crassum, tuberculis superficiei interiore altis 1.0–1.8(–2.2) μm et 0.5–1.1(–1.4) μm latis ornatum, stratum interius flavum ad flavo-aurantium, 0.5–1.3 μm crassum; stratum medium et stratum interior tunicae exterioris rubro vel rubro-brunneo colorantes reagente Melzeri; tunica interior de novo formans stratis tribus hyalinibus, in totum 3.1–4.5(–5.2) μm crassum; scutellum germinale in superficiei exterioris tunicae interioris, hyalinum ad subhyalinum ad albo-flavum; ovale vel ellipsoidum vel rarum subglobosum, 85–125 \times 60–85 μm , lobatum, paucioribus (4–6(–8)) lobis depressionibusque germinationis. Holotypus # 81–8101: URM 79247.

TYPE: 81–8101 (URM 79247, **holotype**) from soil samples from the semi-arid Caatinga biome in the National Park of ‘Vale do Catimbau’ (Municipality of Buique), Pernambuco State, Brazil.

ETYMOLOGY: from the Latin: ‘intra’ (within, inside) and ‘ornata’ (ornamented) referring to the position of the tuberculate ornamentation on the inner surface of the outer spore wall.

SPOROCARP FORMATION is unknown.

GLOMEROSPORES (FIGS. 1–2) formed singly in soils terminally on a subterminal or intercalary bulbous suspensor cell (= ‘sporogenous’ cell; FIGS. 3–4). They are globose (150–260 μm in diameter) to subglobose (145–250 \times 165–280 μm) to rarely irregular, bright yellow to yellow-orange, with two walls: an outer and an inner wall (OW and IW; FIGS. 5–7).

OUTER WALL is three-layered (FIG. 5): outermost wall layer (OWL1) is hyaline to subhyaline, semi-persistent to persistent, 1.1–2.1 μm thick. Second layer (OWL2) is bright yellow to yellow-orange, laminate, and 7.5–14 μm thick, densely packed with tube projections on the inner surface, that are 1.0–1.8(–2.2) μm long and 0.5–1.1(–1.4) μm broad (FIGS. 6–9). Tubes are about 0.6–)1.1–2.5(–3.6) μm apart from each other (FIGS. 2–11). OWL3 is concolorous with OWL2, 0.5–1.3 μm thick, and is profiled by tube projections of OWL2 (FIGS. 6–9). OWL2 and OWL3 sometimes darken to bright orange to orange-red several months after

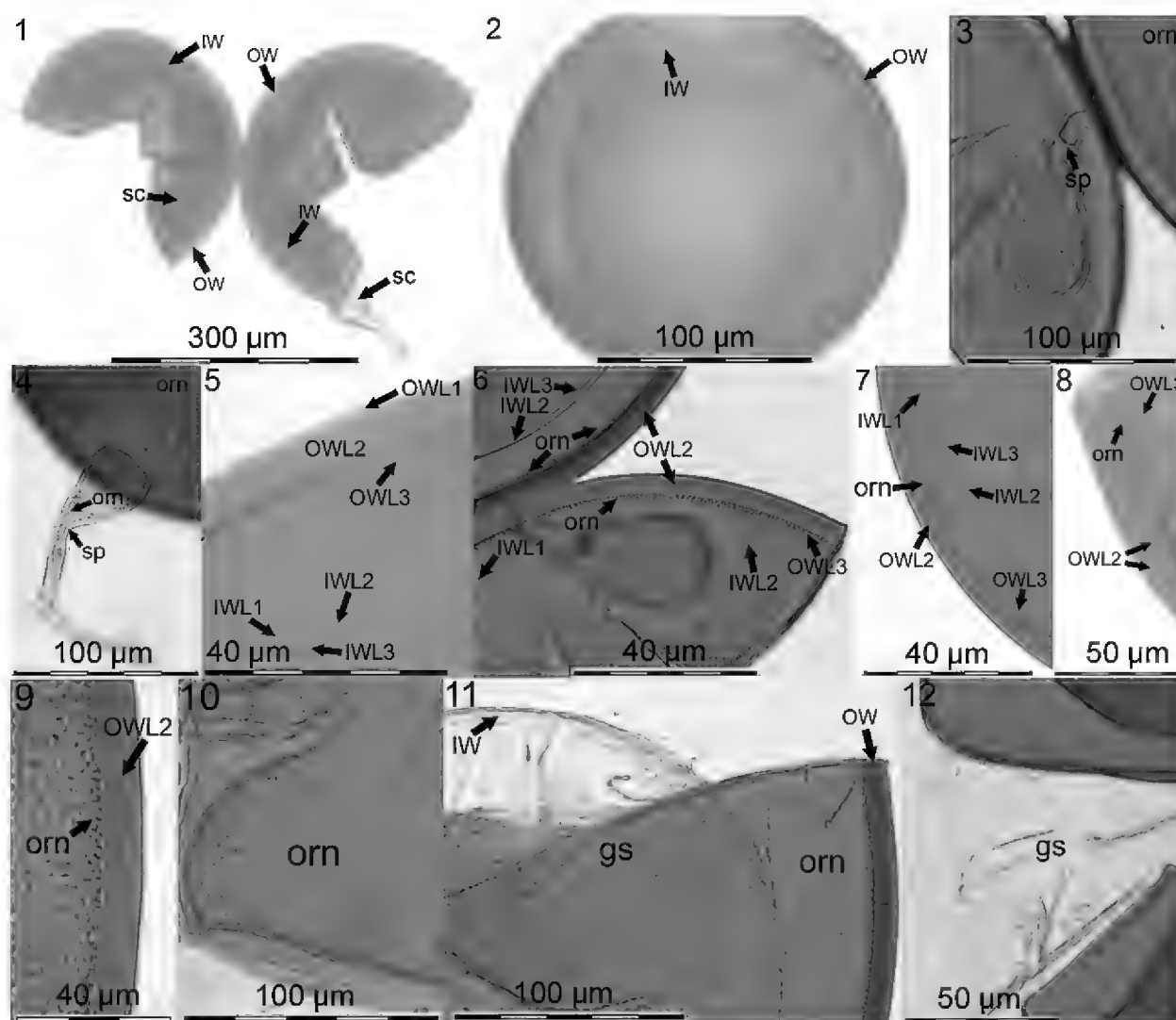
being mounted in PVLG, and both layers stain red to red-brown in Melzer's reagent (FIGS. 9–12). The straight pore channel at the spore base (about 2.5–3.6 μm broad) is rarely closed by a plug formed by spore wall material of OWL2, and by OWL3, but often appears to be open.

INNER WALL is three-layered (FIGS. 5–7), bearing a germination shield on the outer surface (FIG. 11). Outer layer of the inner wall (IWL1) is hyaline, semi-flexible and 0.8–1.6 μm thick. Second layer (IWL2) is unit to finely laminate and 1.9–2.8 μm thick. Innermost layer (IWL3) is thin (0.4–0.8 μm thick), flexible and difficult to observe since generally tightly adherent to IWL2. The three layers do not stain in Melzer's reagent.

SPOROGENOUS CELL is subglobose to elongate, concolorous with the spore, or slightly lighter in color than the spore, and 55–85 μm long and 32–46(–56) μm broad (FIGS. 1, 3–4). Two wall layers are generally visible on the sporogenous cell, continuous with OWL1 and with OWL2. OWL1 on the sporogenous cell is about 0.7–1.9 μm ; adherent OWL2 is about 2.8–4.8 μm thick. The tuberculate ornamentation on OWL2 rarely continues on the wall of the sporogenous cell (FIG. 4). The pore of the sporogenous cell is generally closed at the connection to the attached 'sporogenous hypha' by a septum arising from OWL2. The sporogenous hypha generally is also bi-layered, but OWL1 is evanescent and has often sloughed off completely. In the hypha, usually 6–12(–16) additional septa, arising from OWL2, are visible in up to 150–350(–600) μm distance from the sporogenous cell. Within this distance, the sporogenous hypha tapers from 7.5–12.0 to 5.1–8.3 μm , and the hyphal wall tapers from 2.1–4.8 to 1.1–2.6 μm .

GERMINATION SHIELD is hyaline to subhyaline (to rarely light yellow in older spores), oval to ellipsoid (FIG. 11) or rarely subglobose, 85–125 \times 60–85 μm in diameter, and have 4–6(–8) lobes (FIG. 12), that are difficult to differentiate when the shield cannot readily be observed in planar view. Irregular folds (about 5–15 μm long) arising from the shield wall separate the lobes. The one-layered shield wall and the folds are hyaline to subhyaline and generally only 0.5–1.7 μm thick. Each lobe may bear one rounded germ tube initiation (FIGS. 13–14), 1.7–2.6 μm in diameter, from where the germination tubes emerge during initial germination in *Racocetra* species. The germ tube initiations, however, were difficult to detect in the specimens analyzed.

SPORE DEVELOPMENT could be deduced from unequivocally identified spores found in different developmental stages in the field samples. First the outer wall differentiates a semi-persistent, unit layer (OWL1), a laminate layer with the characteristic tube projections on its inner surface (OWL2), and an adherent thin inner layer (OWL3). After the formation of one to several septa in the sporogenous hypha, separating the cell content of the spore from the hypha,



FIGS. 1–12. *Racocetra intraornata*. FIG. 1. Spores with sporogenous cells (sc) attached. FIG. 2. Uncrushed spore with outer wall (ow) and inner wall (iw); round ornamentation structures visible. FIGS. 3–4. Sporogenous cells with septa (sp) at the cell base. Spore wall ornamentation (orn) rarely continuing onto sc wall (FIG. 4). FIGS. 5–10. Spore wall structure with three-layered outer wall (OWL1–3) and three-layered inner wall (IWL1–3). Characteristic tube ornamentation (orn) on inner surface of structural, laminate layer OWL2, reflected on adherent OWL3. FIG. 8. OWL3 separating from OWL2 through strong pressure applied on cover slide; OWL2 also splitting. FIG. 9. Tube ornamentation on inner lamina of structural OWL2 in cross view. FIG. 10. Dense tube ornamentation in planar view. FIG. 11. Hyaline germination shield on the surface of IW; lobed shield structure difficult to see in cross view. FIG. 12. Germination shield with three lobes visible. Outer wall (OWL2 and OWL3) staining red to red-brown in Melzer's reagent (FIGS. 9–12).

the inner wall develops de novo without visible attachment to the outer wall. Finally, the lobed germination shield develops on the outer surface of the inner wall.

AUXILIARY CELLS were not found.

MYCORRHIZA FORMATION is so far unknown.

DISTRIBUTION hitherto known only from Northeastern Brazil in the semi-arid Caatinga biome (municipality Buique, Pernambuco State) and in a 'restinga'

sand dune ecosystem along the semi-humid Atlantic coast (municipality Mataraca, Paraíba State).

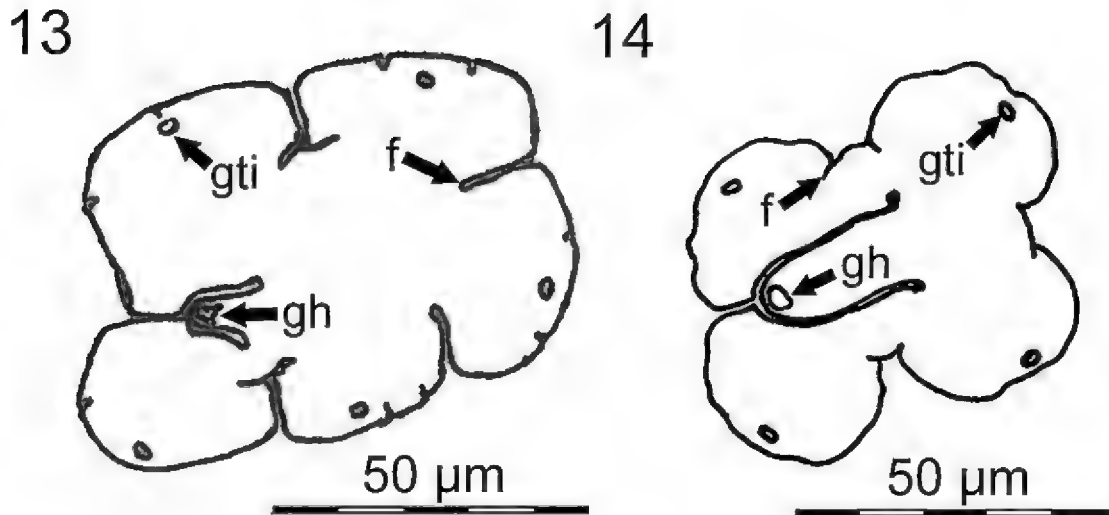
ADDITIONAL SPECIMENS EXAMINED — BRAZIL. Pernambuco State. Buique. Isolated from soil samples from the semi-arid Caatinga biome in the National Park of 'Vale do Catimbau' (Municipality of Buique). Isotype specimens (81–8102 & 81–8103) deposited at URM (Recife, Pernambuco, Brazil). Isotypes 81–8104 & 81–8105 (OSC #134506) deposited at OSC (Corvallis, Oregon, USA). Isotypes 81–8106 & 81–8107 (ZT Myc 775) deposited at Z+ZT (Zurich, Switzerland). Other specimens from the type location area and sand dune ecosystem in Mataraca (Paraíba State) deposited at URM and at Z+ZT.

Discussion

By spore size, color and spore wall structure, and especially by the distinct ornamentation type positioned on the OWL2 inner surface tracing on OWL3 of the outer spore wall, the new species, *Racocetra intraornata*, can easily be distinguished from all other known species in the *Glomeromycetes*.

Racocetra intraornata is thus far the only species in the genus *Racocetra* with ornamentation on the inner surface of the outer wall. The nine other *Racocetra* species known so far (Oehl et al. 2009) have either no ornamentation (*R. alborosea* (Ferrer & R.A. Herrera) Oehl et al. 2009 (Ferrer & Herrera 1981), *R. castanea* (C. Walker) Oehl et al. 2009 (Walker et al. 1993), and *R. fulgida* (Koske & C. Walker) Oehl et al. 2009 and *R. weresubiae* (Koske & C. Walker) Oehl et al. 2009 (Koske & Walker 1986)), or single ornamentations positioned on the outer surface of the spore wall (*R. coralloidea* (Trappe et al.) Oehl et al. 2009 (Gerdemann & Trappe 1974), *R. gregaria* (N.C. Schenck & T.H. Nicolson) Oehl et al. 2009 (Nicolson & Schenck 1979), *R. minuta* (Ferrer & R.A. Herrera) Oehl et al. 2009 (Ferrer & Herrera 1981), and *R. persica* (Koske & C. Walker) Oehl et al. 2009 and *R. verrucosa* (Koske & C. Walker) Oehl et al. 2009 (Koske & Walker 1985)).

There are three other species in the *Gigasporineae* with a double ornamentation on the outer spore wall: *Dentiscutata nigra* (J.F. Redhead) Sieverd. et al. 2009 (Nicolson & Schenck 1979), *D. reticulata* (Koske et al.) Sieverd. et al. 2009 (Koske et al. 1983), and *D. biornata* (Spain et al.) Sieverd. et al. 2009 (Spain et al. 1989b, Oehl et al. 2009). However, the ornamentations of these species either are directed both towards the outer spore surface (in *D. nigra* and *D. reticulata*; Nicolson & Schenck 1989, Koske et al. 1983) or are positioned on the outer and inner ow surfaces, respectively (*D. biornata*; Spain et al. 1989b), while in *R. intraornata* both are equally directed on the inner ow surface (on the adherent layers OWL2 & OWL3) projecting onto smooth iw. Moreover, *D. nigra* ornamentations consist of large pits on the structural, laminated wall layer overlaying a sinuous ornamentation, and *D. reticulata* ornamentations consist of a reticulum bearing spines in the large pits of the structural layer (Nicolson & Schenck 1989, Koske et al. 1983, Oehl et al.



FIGS. 13–14. *Racocetra intraornata* — drawings of germination shields in planar view. Germination shield with an initial germ hole (gh) and with several lobes each generally bearing one germ tube initiation (gti). The shield on the right appears to be more openly organized than the shield on the left, but it should be considered that the shield organization may change dependent on the pressure applied to the cover slide to make the shield more visible or to separate it from the inner wall.

2009). On the inner OW surface, only *D. biornata* has a similar fine-structured ornamentation (positioned on OWL3) as found for *R. intraornata*, but in *D. biornata* this layer easily detaches from the smooth, adherent OWL2 structural layer and consists of blunt projections, while in *R. intraornata*, OWL3 can only, if at all, be separated from the tuberculate projections of the structural OWL2 when harsh pressure is applied on the cover slide (FIG. 8). Finally, all three cited *Dentiscutata* species have significantly larger and darker colored spores than *R. intraornata* and, as typical for *Dentiscutata* species, three spore walls and conspicuous yellow-brown to brown, multiply compartmented shields with 12–30 small compartments and gti (Oehl et al. 2009).

The ornamentation on the ow inner surface in *R. intraornata* resembles germ warts of the germinal wall layer in *Gigaspora* species, but the *Gigaspora* warts are on the surface of the thin innermost layer (Spain et al. 1989a, Maia & Kimbrough 1993, Maia et al. 1994), while the *R. intraornata* tube ornamentation is on the innermost lamina of the structural layer OWL2 profiling into thin OWL3. Nevertheless, we speculate that the new species might be closely related evolutionarily to *Gigaspora* and thus possibly able to germinate not only from a germ tube initiation of the germ shield but also from the warty structure of the outer wall. This inference is not yet supported, although recent phylogenetic trees published by de Souza et al. (2005) and Sýkorová et al. (2007) do support a close evolutionary relationship between *Racocetra* spp. (e.g. *R. castanea*, *R. fulgida*) and *Gigaspora* spp. In this respect, our observation that all known *Gigaspora* and *Racocetra* species show a staining reaction on the outer spore wall in Melzer's reagent is noteworthy (see also Oehl et al. 2009).

Despite several attempts, the new species did not grow in bait cultures or in single species cultures. Nevertheless, we assume that *R. intraornata* form arbuscular mycorrhiza on plants without intraradical vesicle formation, as assumed for all *Diversisporales* forming spores on sporogenous cells, i.e. in the sub-order *Gigasporineae* sensu Morton & Benny (1990).

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Literature cited

- Brundrett M, Melville L, Peterson L. 1994. Practical Methods in Mycorrhizal Research. University of Guelph, Guelph, Ontario, Canada, Mycologue Publications.
- De Souza FA, Declerck S, Smit E, Kowalchuk GA. 2005. Morphological, ontogenetic and molecular characterization of *Scutellospora reticulata* (*Glomeromycota*). Mycol. Res. 109: 697–706.
- Ferrer RL, Herrera RA. 1981 ['1980']. El genero *Gigaspora* Gerdemann et Trappe (*Endogonaceae*) en Cuba. Rev. Jardin Bot. Nacional Habana 1: 43–66.
- Gerdemann JW, Nicolson TH. 1963. Spores of mycorrhizal *Endogone* species extracted from soil by wet sieving and decanting. Trans. Br. Mycol. Soc. 46: 235–244.
- Gerdemann JW, Trappe JM. 1974. The *Endogonaceae* in the Pacific Northwest. Mycologia Memoir No. 5. 76 pp.
- Gomes APS, Rodal MJN, Melo AL. 2006. Florística e fitogeografia da vegetação arbustiva subcaducifolia da Chapada de São José, Buique, PE, Brasil. Acta Bot. Bras. 20: 37–48.
- Goto BT, Maia LC. 2006. Glomerospores, a new denomination for the spores of *Glomeromycota*, a group molecularly distinct from *Zygomycota*. Mycotaxon 96: 129–132.
- Jenkins WR. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Dis. Rep. 48: 692.
- Koske RE, Walker C. 1985. Species of *Gigaspora* (*Endogonaceae*) with roughened walls. Mycologia 77: 702–720.
- Koske RE, Walker C. 1986. Species of *Scutellospora* (*Endogonaceae*) with smooth-walled spores from maritime sand dunes: Two new species and a redescription of the spores of *Scutellospora pellucida* and *Scutellospora calospora*. Mycotaxon 27: 219–235.
- Koske RE, Miller DD, Walker C. 1983. *Gigaspora reticulata*: a newly described endomycorrhizal fungus from New England. Mycotaxon 26: 429–435.
- Maia LC, Kimbrough JW. 1993. Ultrastructure of the spore wall of *Gigaspora albida*. Mycologia 85: 883–889.

- Maia LC, Kimbrough JW, Benny GL. 1994. Ultrastructure of spore germination in *Gigaspora albida*. *Mycologia* 86: 343–349.
- Morton JB, Benny GL. 1990. Revised classification of arbuscular mycorrhizal fungi (*Zygomycetes*). A new order, *Glomales*, two new suborders, *Glomineae* and *Gigasporineae*, and two new families, *Acaulosporaceae* and *Gigasporaceae*, with an emendation of *Glomaceae*. *Mycotaxon* 37: 471–491.
- Nelson WL, Mehlich A, Winters E. 1953. The development, evaluation and use of soil tests for phosphorus availability. In: Pierre WH, Norman AF. Soil and fertilizers phosphorus in crop nutrition. Aponany Monogr. Academic Press, New York. pp. 153–188.
- Nicolson TH, Schenck NC. 1979. Endogonaceous mycorrhizal endophytes from Florida. *Mycologia* 71: 178–198.
- Oehl F, de Souza FA, Sieverding E. 2009 [‘2008’]. Revision of *Scutellospora* and description of five new genera and three new families in the arbuscular mycorrhiza-forming *Glomeromycetes*. *Mycotaxon* 106: 311–360.
- Oehl F, Sýkorová Z, Redecker D, Wiemken A, Sieverding E. 2006. *Acaulospora alpina*, a new arbuscular mycorrhizal fungal species characteristic for high mountainous and alpine grasslands of the Swiss Alps. *Mycologia* 98: 286–294.
- Oliveira-Filho AT, Carvalho DA. 1993. Florística e fisionomia da vegetação no extremo norte do litoral da Paraíba. *Rev. bras. Bot.* 16: 115–130.
- Palenzuela J, Ferrol N, Boller T, Azcón-Aguilar C, Oehl F. 2008. *Otospora bareai*, a new fungal species in the *Glomeromycetes* from a dolomitic shrub-land in the Natural Park of Sierra de Baza (Granada, Spain). *Mycologia* 100: 296–305.
- Sieverding E, Oehl F. 2006. Revision of *Entrophospora*, and description of *Kuklospora* and *Intraspora*, two new genera in the arbuscular mycorrhizal *Glomeromycetes*. *J. Appl. Bot. Food Qual – Angew. Bot.* 80: 69–81.
- Souza RG. 2008. Aspectos ecológicos e introdução de mudas micorrizadas para revegetação de áreas de dunas mineradas, no litoral da Paraíba. PhD Thesis, Recife, Universidade Federal de Pernambuco.
- Spain JL Sieverding E, Schenck NC. 1989a. *Gigaspora ramisporophora*: a new species with novel sporophores from Brazil. *Mycotaxon* 34: 667–677.
- Spain JL, Sieverding E, Toro S. 1989b. *Scutellospora biornata*, a new species in the *Endogonaceae* from the Llanos Orientales of Colombia. *Mycologia* 35: 219–227.
- Sýkorová Z, Ineichen K, Wiemken A, Redecker D. 2007. The cultivation bias: different communities of arbuscular mycorrhizal fungi detected in roots from the field, from bait plants transplanted to the field, and from a greenhouse trap experiment. *Mycorrhiza* 18: 1–14.
- Walker C, Sanders FE. 1986. Taxonomic concepts in the Endogonaceae: III. The separation of *Scutellospora* gen. nov. from *Gigaspora* Gerd. & Trappe. *Mycotaxon* 27: 169–182.
- Walker C, Gianinazzi-Pearson V, Marion-Espinasse H. 1993. *Scutellospora castanea*, a newly described arbuscular mycorrhizal fungus. *Cryptogamie* 14: 279–286.

Two new species of *Stemphylium* from Sinkiang, China

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Abstract — Two new species of *Stemphylium* from Sinkiang province in China are described and illustrated: *Stemphylium cremanthodii* and *S. amaranthi*. The type specimens are deposited in the Herbarium of the Department of Plant Pathology, Shandong Agricultural University (HSAUP), ex-type cultures at Centraalbureau voor Schimmelcultures (CBS).

Key words — hyphomycetes, taxonomy

Introduction

Wallroth (1833) erected the genus *Stemphylium* based on the type species, *Stemphylium botryosum* Wallr. 1833. Simmons (1967) delineated this genus by the following criteria that distinguish it from *Ulocladium* and *Alternaria*: (i) The percurrently proliferating conidiophore is the principal morphological characteristic of *Stemphylium* and (ii) the apical cell of a simple *Stemphylium* conidiophore was slightly to distinctly swollen. Câmara et al. (2002) recognized 33 species of *Stemphylium* worldwide. In recent years we have isolated numerous strains of *Stemphylium* spp. from leafspots on various plants, finding two hitherto undescribed fungi. These two *Stemphylium* species were isolated from necrotic leafspots on *Cremanthodium discoideum* and *Amaranthus retroflexus* from Sinkiang province in China.

Materials and methods

The specimens were collected from black spots on living leaves of plants during 2007–2008. Fungi were isolated by moistening the leaves, then picking single conidia growing from the tissues in Petri dishes. Those isolates were cultured on PDA (potato-dextrose agar) at 23°C and transferred to PCA (potato-carrot agar) after 3–5 days. Morphological descriptions of *Stemphylium* spp. were

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based on cultures that developed under standardized conditions (Simmons & Roberts 1993): potato-carrot agar (PCA) at ambient room temperature 23°C, under a daily fluorescent light/dark cycle of 8/16 h, and examined after 2–3 weeks. All microscopic characteristics were determined on the basis of measurements of 50 mature conidia and 30 conidiophores mounted in lactic acid at 100 × magnification.

Taxonomic descriptions

Stemphylium cremanthodii Y.F. Pei & X.G. Zhang, sp. nov.

FIGURE 1

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Ex culturis in agaro ‘potato-carrot’ descripta. Coloniae effusae, pallide brunneae vel medio-brunneae. Mycelium superficiale, hyphae ramosae, septatae, pallide brunneae, laeves, 2.5–4.0 μm latae. Conidiophora solitaria, nonramosa vel raro ramosa, recta vel curvata, pallide brunnea vel medio-brunnea, laevia, 2–6-septata, 36–67 × 3.5–5.0 μm, cylindrica, ad apicem usque 6.5–7.5 μm inflata, saepe unus vel bis proliferationis. Conidia singularia ex apice conidiophori et eius proliferationis oriunda, medio-brunnea, oblonga vel oblonga-ellipsoidea, ad apicem subtruncata, ad basim rotundata vel subtruncata, recta vel leviter curvata, 1–3 transversalibus septata, 1 plerumque ad mediano distincte constricta, 0–3 longitudinalibus vel obliquis septata, 18–31 × 9–19 μm, micromaculatus.

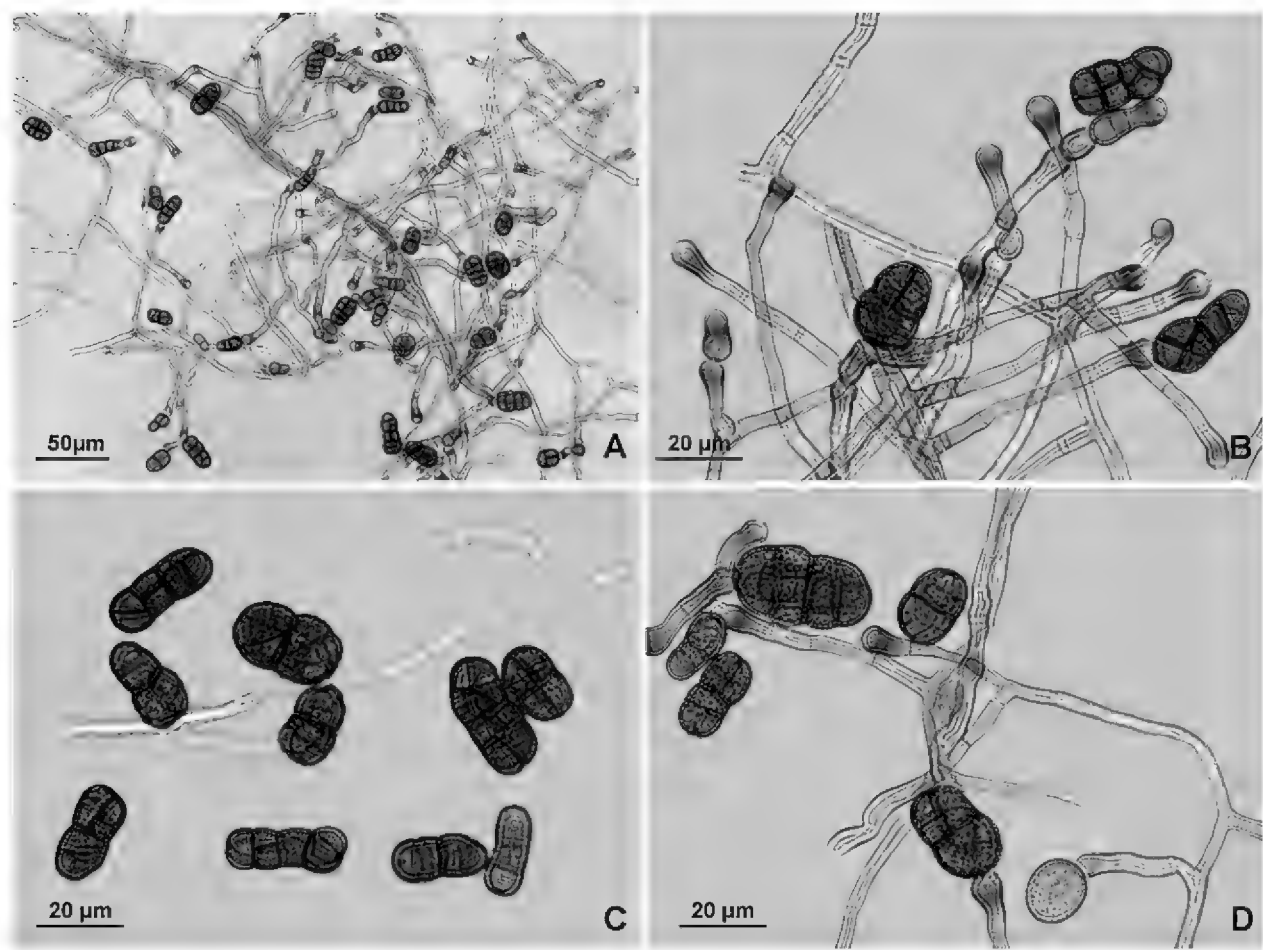


FIG. 1. *Stemphylium cremanthodii*.

A–C. Characteristics of mature conidia and conidiophores. D. Ornamentation of mature conidia.

HOLOTYPE: on leaves of *Cremanthodium discoideum* Maxim. (Asteraceae), pear orchards of Korla, Sinkiang province, Northwestern China. Otc. 16. 2008, Y.F. Pei, HSAUPpyf1830(1).

ETYMOLOGY: in reference to the host genus, *Cremanthodium*.

Colonies on PCA effuse, pale brown to medium brown. Mycelium superficial, composed of branched, septate, pale brown, smooth, hyphae 2.5–4.0 µm wide. Conidiophores solitary, unbranched or occasionally branched, straight or curved, pale brown to medium brown, smooth, 2–6-septate, 36–67 × 3.5–5.0 µm, cylindrical, at the apex 1–2 percurrent proliferations which are swollen to 6.5–7.5 µm (FIG. 1B). Conidia develop singly through a narrow pore at the apex of each conidiophore, medium brown, oblong to oblong-ellipsoid, subtruncate at the apex, rounded or subtruncate at the base, straight or slightly curved, with 1–3 transverse septa and usually distinctly constricted in the middle, 0–3 longitudinal or oblique septa, 18–31 × 9–19 µm (av. 22.5 × 14.5 µm), L/W ratio is 1.5–2.6 (av. 2.0), micromaculate (FIG. 1C–D).

The conidia of this fungus resemble those of *S. eturmiunum* (Simmons 2001). Mature conidia of *S. cremanthodii* are cylindrical or oblong-ellipsoid, while those of *S. eturmiunum* are broadly ovoid or ellipsoid. On the other hand, the longer conidiophores differentiate *S. cremanthodii* from *S. eturmiunum* (10–40 µm). In addition, the ornamented conidial walls of *S. cremanthodii* are micromaculate, while those of *S. eturmiunum* are punctulate to punctate. Otherwise, a minor portion of conidia of *S. eturmiunum* have more transverse septa than those of *S. cremanthodii*.

***Stemphylium amaranthi* Y.F. Pei & X.G. Zhang, sp. nov.**

FIGURE 2

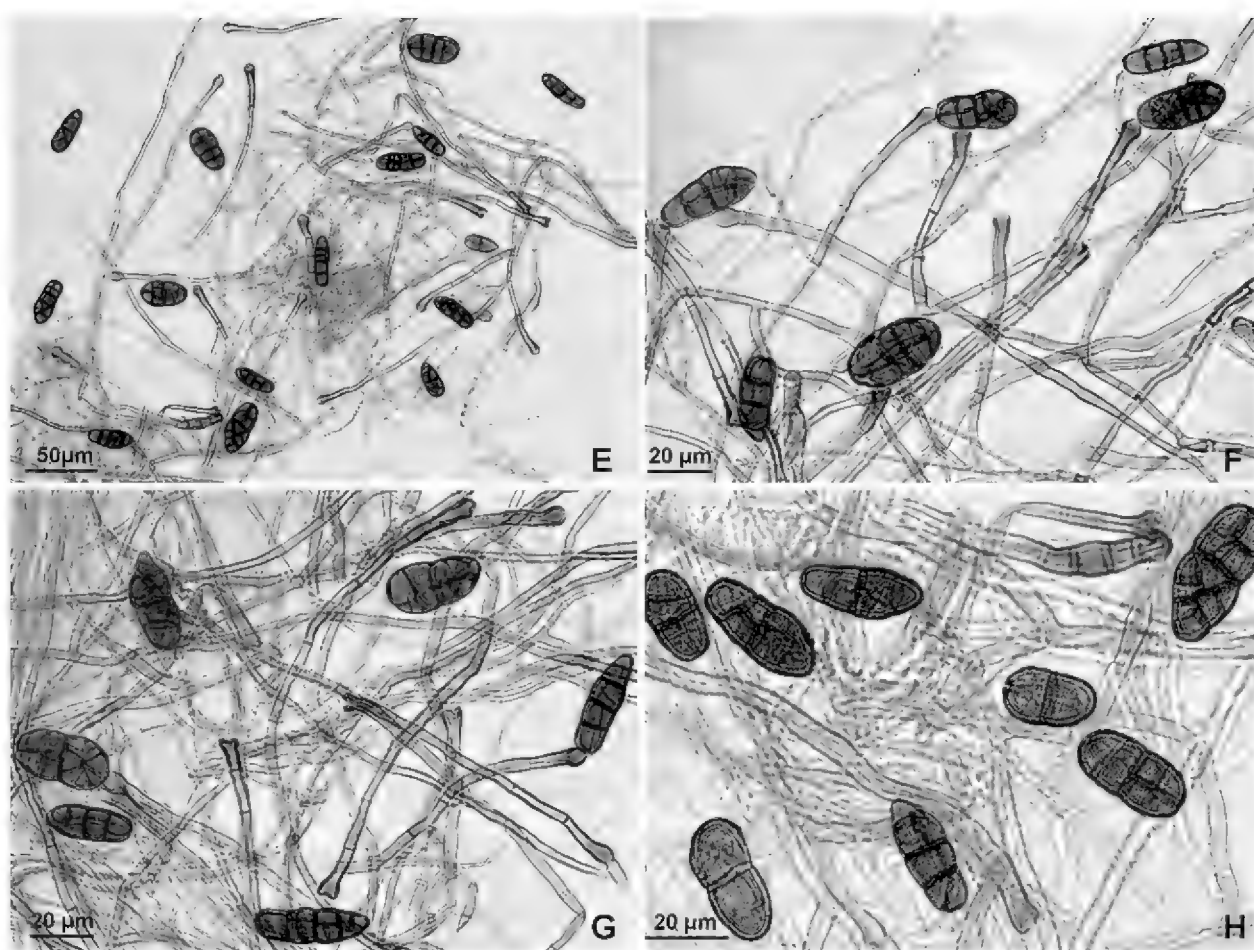
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Ex culturis in agaro 'potato-carrot' descripta. Coloniae effusae, pallide brunneae vel medio-brunneae. Mycelium superficiale, hyphae ramosae, septatae, pallide brunneae, laeves, 3.5–4.5 µm latae. Conidiophora solitaria, nonramosa vel raro ramosa, recta vel curvata, pallide brunnea, laevia, 3–7-septata, 55–160 × 5.5–6.5 µm, cylindrica, ad apicem usque 5.5–6.5 µm inflata. Conidia singularia ex apicem conidiophori et eius proliferationis oriunda, late ovoidea, gracilis-ellipsoidea vel oblonga-ellipsoidea, ad apicem subacutis vel obtusos, ad basim rotundata vel subtruncata, recta vel leviter curvata, pallidae brunnea vel medio-brunnea, cylindrica, 1–3–(4) transversalibus septata, 1 plerumque ad mediano distincte constricta, 0–3 longitudinalibus vel obliquis septata, 22–35 × 10–19 µm, unconspectue micromaculatus.

HOLOTYPE: on leaves of *Amaranthus retroflexus* L. (Amaranthaceae), pears orchards of Korla, Sinkiang province, Northwestern China. Otc. 17. 2008, Y.F. Pei, HSAUPpyf1835(2).

ETYMOLOGY: in reference to the host genus, *Amaranthus*.

Colonies on PCA spreading, pale brown to medium brown. Mycelium superficial, hyphae branched, septate, pale brown, smooth, 3.5–4.5 µm wide. Conidiophores solitary, unbranched or occasionally branched, straight or

FIG.. 2. *Stemphylium amaranthi*.

E–G. Characteristics of mature conidia and conidiophores. H. Ornamentation of mature conidia.

curved, pale brown, smooth, 3–7-septate, $55\text{--}160 \times 5.5\text{--}6.5 \mu\text{m}$ cylindrical, swollen at the apex $5.5\text{--}6.5 \mu\text{m}$ diam and distinctly flared (FIG. 2E). Conidia develop singly through a narrow pore at the apex of each conidiophore, pale brown to medium brown, broadly ovoid, slender-ellipsoid or oblong-ellipsoid, subacute to obtuse at the apex, rounded or subtruncate at the base, straight or slightly curved, with 1–3–(4) transverse septa, usually 1 distinctly constricted at the median, and 0–3 longitudinal or oblique septa, $22\text{--}35 \times 10\text{--}19 \mu\text{m}$ (av. $29.5 \times 14.5 \mu\text{m}$), L/W ratio is 1.5–2.6 (av. 2.1), inconspicuously micromaculate (FIG. 2G–H).

The conidia of *S. amaranthi* are similar in shape to those of *S. bolickii* (Sobers & Seymour 1963). However, this species produces smaller conidia than *S. bolickii* ($30\text{--}56 \times 13\text{--}21 \mu\text{m}$). Meanwhile, the conidia of *S. bolickii* have prominent basal scars, while those of *S. amaranthi* do not. Furthermore, the conidial wall ornamentation in *S. amaranthi* distinctly differs from the moderately verrucose ornamentation in *S. bolickii*.

Acknowledgments

The authors are grateful to Dr. W.B. Kendrick and Dr. N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (no. 30570006).

Literature cited

- Câmara MPS, O'Neill NR, van Berkum P. 2002. Phylogeny of *Stemphylium* spp. based on ITS and glyceraldehyde-3-phosphate dehydrogenase gene sequences. *Mycologia* 94(4): 660–672.
- Simmons EG. 1967. Typification of *Alternaria*, *Stemphylium*, and *Ulocladium*. *Mycologia*, 59: 67–92.
- Simmons EG. 2001. Perfect states of *Stemphylium* IV. *Harvard Papers in Botany* 6(1): 199–208.
- Simmons EG, Roberts RG. 1993. *Alternaria* themes and variations (73). *Mycotaxon* 48: 109–140.
- Sobers EK, Seymour CP. 1963. *Stemphylium* leafspot of *Echeveria*, *Kalanchoë*, and *Sedum*. *Phytopathology* 53: 1443–1446.
- Wallroth FG. 1833. *Flora Cryptogamica Germaniae*, pars. post. Nürnberg: J.L. Schrag. 923 pp.

***Glomus custos* sp. nov., isolated from a naturally heavy metal-polluted environment in southern Spain**

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Abstract — An undescribed species of the arbuscular mycorrhizal (AM) fungi (*Glomeraceae*, *Glomeromycetes*) was isolated from the bank side of the Rio Tinto River (Huelva, Spain), a naturally heavy-metal polluted environment. The species description is based on spore morphological parameters from in vitro root organ cultures, in vivo pot cultures, in vitro colony morphogenesis, and molecular analyses. Mature in vitro grown and pot cultured spores are pale to brownish yellow, globose to subglobose, 110–172 µm diameter and characterized by 4-layered walls. Phylogenetic analyses of the entire rDNA ITS region place the species into the *Glomeraceae* (group A) without closely related homology with known species. *Glomus custos* forms vesicular-arbuscular mycorrhizae with leek and clover plants under in vivo growing conditions and with excised carrot roots under in vitro propagation. The name *custos* (guardian) refers to the protective properties this fungus confers to host plants in terms of resistance to extreme pH and heavy metal concentrations in soil.

Key words — root organ cultures, molecular phylogeny, new species

Introduction

Spores of a distinct arbuscular mycorrhizal (AM) fungus from a soil sample of a bank of the Rio Tinto River (Huelva, Spain) were isolated and cultures were established under in vitro monoxenic conditions with carrot transformed root organ culture and under in vivo pot-cultures of leek and clover plants. Given that the species population of a given AM fungi community is largely influenced by the land use profile (Li et al. 2007), it becomes important to

identify and characterize a species capable of proliferating in such inhospitable environmental conditions in view of restoration efforts and physiological studies of adaptability of AM fungi.

The Rio Tinto River area is named after the reddish-color of its water, which contains extremely high heavy metal concentrations. When examined, the glomoid spores isolated from the Rio Tinto heavy-metal polluted site differed from published species by their spore wall architecture. Phylogenetic analysis of partial rDNA 18S subunit showed close similarity with group A of the *Glomeraceae* sensu Schüssler et al. (2001) with high homology to *Glomus intraradices* N.C. Schenck & G.S. Sm. 1982. Further analysis of total Internal Transcribed Spacer (ITS) region sequences clearly distinguished *G. custos* from previously described species. Based on morphological and molecular differences, *G. custos* sp. nov. is proposed and described as a new arbuscular mycorrhizal fungi species of the *Glomeromycota*.

Materials and methods

Monoxenic culture of the fungal isolate

Trap plants using natural soil collected from several sites by the Rio Tinto river (Southwestern Spain, Huelva province, 37°42'N/6°36'W) were established and thirty months later spores were isolated from pot cultures (Sieverding 1991), surface-sterilized (Cano et al. 2008), and plated for germination under sterile conditions in a water-agar medium (0.8%, Bacto-Difco agar), and maintained in the dark at 24° C for 10 to 14 days. Germinated spores were transferred (one spore per plate, i.e. monosporic cultures) onto Petri plates containing fresh “minimal medium” (Bago et al. 2004) in which a Ri-T DNA-transformed carrot root organ culture (ROC, DC-2 clone) was vigorously growing. After three weeks, vigorously growing hyphae and branched absorbing structures (BAS) (Bago et al. 1998) began to differentiate, indicating the successful establishment of the Rio Tinto AMF isolate culture. The mother culture was subcultured by transferring plugs of culture medium containing both extraradical mycelium (ERM) and spores to fresh DC-2 ROCs. Tracks of culture traceability have been recorded up to date. Aseptic spores were extracted from in vitro cultures and used to establish pot cultures under greenhouse conditions with *Medicago sativa* L., *Allium porrum* L., and *Lactuca sativa* L. as host plants.

Light and electron microscopy

The spores, from all stages of development, differentiated under in vitro and in vivo cultures were mounted on microscopic slides in polyvinyl alcohol/lactic acid/glycerol (PVLG) (Omar et al. 1979) and in PVLG – Melzer's reagent (1:1, v/v) solution. Terminology of spore characters followed that of Walker (1983) and Stürmer & Morton (1997). Color observations referred to the International Culture Collection of Arbuscular and Vesicular-Arbuscular Mycorrhizal Fungi (INVAM; <http://invam.caf.wvu.edu/>) color chart codes. Photographs were taken with a Nikon CoolPix 4500 digital camera installed on a Nikon Eclipse 800 compound microscope equipped with

Nomarski differential interference contrast optics. Reference specimens were deposited at the Herbario de la Universidad de Granada (GDA), Spain, the National Mycological Herbarium (DAOM) Canada, the *Glomeromycota* in vitro collection Canada, and the Mycothèque de l'Université catholique de Louvain (MUCL), Belgium.

For transmission electron microscopy (TEM), spores were fixed in a 2.8% glutaraldehyde, 1.5% p-formaldehyde in a 0.2 M phosphate buffer at 4° C for 18 h, washed and centrifuge in a 0.1 M phosphate buffer, and in double distilled water, post-fixed in 2% aqueous osmic acid, dehydrated, stained with uranyl acetate, and embedded in LRWhite (London Resin Company Ltd.). Ultrathin sections were mounted on grids and observed under a Zeiss EM902 electron microscope at 80 kv.

Fungi development under monoxenic cultures

Extraradical mycelium development was observed weekly using a Nikon AFX stereomicroscope with special attention paid to BAS and spore differentiation. Intraradical AM colonization was assessed in selected ROC zones, close to the AMF inoculum source, (Cano & Bago 2006) followed by trypan blue staining (Phillips & Hayman 1970), and mounted in lactic acid on microscope slides and percent root colonization estimated (Trouvelot et al. 1986).

Molecular analyses

PCR ANALYSES ON 18S DNA. Approximately 1000 spores were sampled from the monoxenic cultures by dissolving the monoxenic culture medium, according to the method of Doner & Bécard (1991). The DNA extraction followed Declerck et al. (2000) protocol. PCR reactions were conducted on 1/10 of the DNA extract. The following reactivities were added: 1x PCR buffer (20 mM Tris-HCl (pH 8.4), 50 mM KCl, Invitrogen, USA), 1.5 mM MgCl₂, 0.2 µM of each rDNA primer, 200 µM each dNTP (Finnzymes Oy, Finland), 2.5 units of the Taq DNA polymerase (Invitrogen, USA). The two primers used were VANS1: TCTAGTATAATC GTTATACAGG (Simon et al. 1993) and NS8: TCCTCCGCTTATTGA TATGC (White et al. 1990). The amplification was performed in a PTC 200 DNA engine (MJ Research, USA) under the following successive steps: denaturation at 94 °C for 5 min followed by 40 cycles at 94 °C for 30 s, 55 °C for 1 min, 72 °C for 2 min with a last cycle at 72° for 7 min. PCR product was cloned in *Escherichia coli* using the Gateway cloning system (Invitrogen, USA) and sequenced using the kit DYEnamic ET terminator cycle sequencing kit (cat n° US 810 50, Amersham Pharmacia Biotech, GB). Clones were sequenced using the following primers NS1, NS2, NS3, NS4, NS5, NS6, NS7, NS8 (White et al. 1990). The sequences were analyzed with an automatic sequencer (CEQ™ 2000 XL DNA analysis system, Beckam Coulter Inc., USA), edited with Sequencher v.4.1.4 (Gene Code Corporation, Ann Arbor, MI), aligned with clustal X 1.5 (Thompson et al. 1997) and corrected manually.

PCR ANALYSIS ON ITS DNA. The rDNA ITS were amplified with the primers pairs ITS5 (5'-GGAAGTAAAAGTCGTAACAAGG-3'), ITS4 (5'-TCCTCCGCTTATTGATATGC-3') and ITS1 (5'-TCCGTAGGTGAACCTGCGG-3'), ITS4 (White et al. 1990), and GLO2A (5'-CGTAACAAGGTTTCCGTAGG-3'), GLO2R (5'-GCGGGTACTCCTAC CTGATT-3'). Precloning PCR was as follow: 3 min at 94°, 38 cycles at 94° for 30 sec, 50° for 60 sec, 72° for 90 sec, with a last cycle of 7 min at 72°. Electrophoresis gels [1.4%

agarose LE (Roche Diagnostics GmbH, Mannheim, Germany) in TAE 1X (Gibco)] were stained with ethidium bromide and photographed under UV light. DNA purification (QIAquick, QIAGEN) and cloning (QIAGEN PCR cloning^{plus} kit, catalogue 231224) were performed following the instructions of the manufacturer on all species for the rDNA ITS and on *G. claroideum* N.C.Schenck & G.S.Sm. 1982 amplified with N4/N629. The sequences were analyzed using 3130XL Genetic Analysers (Applied Biosystems). Between 2 and 8 molecular clones (average of four) of each strain were selected for rDNA ITS and ten of *G. claroideum*. Sequences were aligned with ClustalX v1.83 (Thompson et al. 1997) and manually adjusted with Se-Al v2.0a11 (Rambaut 1996). Aligned sequences were analysed using MrBayes v3.1.2 (Ronquist & Huelsenbeck 2003). The number of substitution type was set to 6 (general time reversible model (GTR). Four chains of Markov were run over 300 000 to 1.5M generations for an average standard variation of split frequencies below 0.01. Trees were sampled every 100th generation, and the burning value set to 10%. Dendrograms produced by this Bayesian analysis are shown as 50% majority rule consensus. For both 18S and ITS, sequence homologies were calculated by “BLAST Align 2 sequences” (<http://blast.ncbi.nlm.nih.gov/Blast.cgi>).

Taxonomic description

Glomus custos C. Cano & Y. Dalpé, sp. nov.

FIGS 1–19

MYCOBANK MB 514011

Sporocarpia ignota. Sporae singulae vel laxe gregariae, intra vel extra radices efformatae. Juveniles sporae efformatae in vivo et in vitro, hyalinae vel flavidae, globosae vel subglobosae, 42–90 µm diam., ovoideae vel piriformes, 62–67 × 72–77 µm diam. laevi externa faciei. Juvenilium sporarum tunicae stratis tribus 2.0–4.8 µm crassae; tunica externa hyalina, 0.5–1.0 µm crassa, mucilagina, evanescens; stratum secundum hyalinum, 1.0–1.5 µm crassum laeve, rigidum, aliquando duplo; stratum tertium hyalinum vel flavidum, 1.6–2.8 µm crassum. Maturae sporae efformatae in vivo et in vitro, flavidae vel luteo-brunneae, globosae vel subglobosae, 110–172 µm diam. ovoideae, ellipsoideae, vel tuberculatae, 72–91 × 104–124 µm. Maturarum sporarum tunicae, stratis quatuor; tunica externa hyalina, 0.8–2.5 µm crassa, mucilagina, evanescens; stratum secundum hyalinum, 1.6–2.8 µm crassum, rigidum, strato uno adhaerente; stratum tertium hyalinum vel flavidum, semiflexibile, 1.5–2.0 µm crassum; stratum quartum luteum vel luteo-brunneum, laminatum, 2.6–3.8 µm crassum. Hypha sustinente singula, cylindrica vel subinfudibuliforme, 9.6–12.8 µm diam. Porus apertus 1.5–2.6 µm latus, raro septo curvo clausus. Mycorrhizae cum vesiculis et arbusculis formantes.

HOLOTYPE. SPAIN, isolated from pot culture at Estación Experimental de Zaidín, Granada, inoculated with a field sample from Rio Tinto, Huelva. GDA 51.596

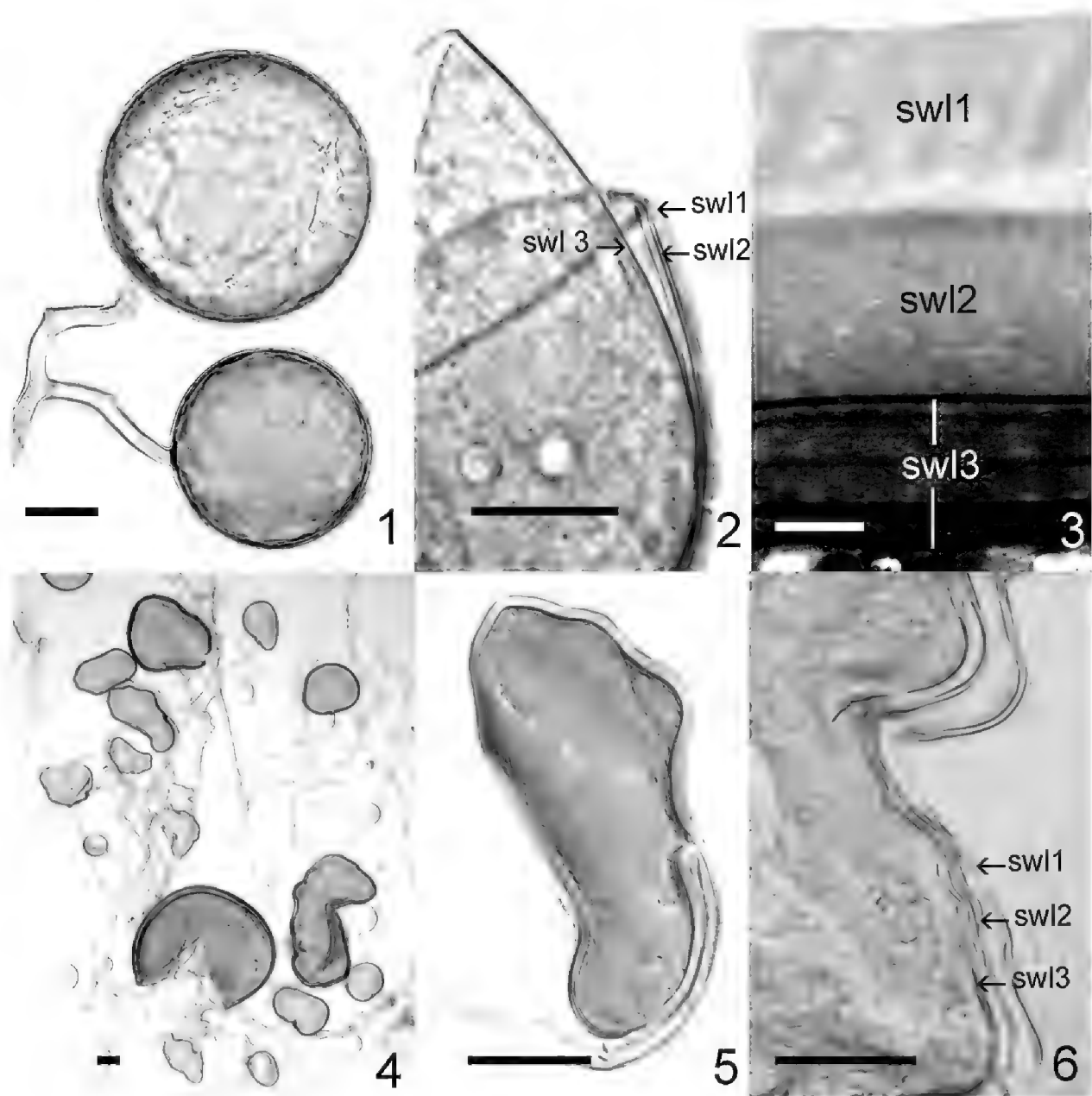
ETYMOLOGY. Latin *custos*, «guardian, protector» referring to the protective properties conferred by this fungus to the plant host, e.g. superior resistance to extreme pH and heavy metal concentrations.

SPOROCARPS unknown. Spores formed in roots and soil, singly or in loose clusters of 2–5 spores, under in vitro cultures, spores differentiated distally or intercalary along hyphal ramifications, the distal hyphae rapidly septated and collapsed.

JUVENILE SPORES from 4 months old in vitro cultures and from pot-cultures, established from in-vitro grown spores (FIG.1, 4–5), hyaline to pale yellow, globose, 42–90 μm in diameter, ovoid to pyriform, 42–57 \times 72–77 μm in diameter, surface smooth. SPORE WALL OF JUVENILE SPORES (FIGS 2–3,6) made of 3 detectable spore wall layers, 2.0–4.8 μm total thickness. Outer layer (SWL 1) hyaline, 0.5–1.0 μm thick, mucilaginous, evanescent, staining reddish with Melzer's reagent; middle layer (SWL 2) hyaline, 1.0–1.5 μm thick, rigid, sometimes double, distinguishable but not easily detachable from layer 1, non reactive to Melzer's; inner layer (SWL 4) hyaline to pale yellow, 1.6–2.8 μm thick, laminated with loose arrangement of laminations, only slightly reactive to Melzer's. SUBTENDING HYPHAE OF JUVENILE SPORES persistent to spore, straight to slightly flared, (6.4–)9.6–14.4 μm broad at the spore base. Pore open, 6.4–7.2 μm . Subtending hyphal wall, continuous with the three spore wall layers, 3.6–4.8 μm thick at point of spore attachment, decreasing to 1.5–2.0 μm thick at 30–35 μm from the spore. Outer layer (SWL 1) thinning shortly, within 5–10 μm along the subtending hypha, inner hyphal wall layers detectable to up to 30 μm along the hyphae.

MATURE SPORES from 12 months old in vitro cultures and from pot cultures established from in-vitro grown spores (Figs 7–13), pale yellow (0/0/60/0), to brownish yellow (0/30/100/0), globose to subglobose, 110–172 μm in diameter (mean size 148 μm), sometimes ovoid, amygdaloid to tuberculated, 72–91 \times 104–124 μm in size. SPORE WALL OF MATURE SPORES made of 4 wall layers. SWL 1 hyaline, mucilaginous, smooth but of irregular thickness, 0.8–2.5 μm thick, reddish with Melzer's reagent, always present on in vitro cultured spores, rarely absent but much thinner with pot culture spores. SWL 2 hyaline (0/0/60/0), rigid, 1.6–2.8 μm thick, outer surface smooth, inner surface occasionally granular on pot cultivated spores, non reactive to Melzer's reagent. SWL 3 hyaline to pale yellow, semi-flexible, surface smooth, easily separated from SWL2, 1.5–2.0 μm thick, non reactive to Melzer's reagent. SWL 4, yellow (0/10/80/0) to brownish yellow (0/30/100/0), laminated, 2.6–3.8 μm thick, strongly reactive to Melzer's reagent staining dark red. Spore wall of irregular shaped spores made of 3 detectable layers; SWL 3 may be absent similarly to juvenile spores, not reactive to Melzer's reagent in contrast to SWL 4.

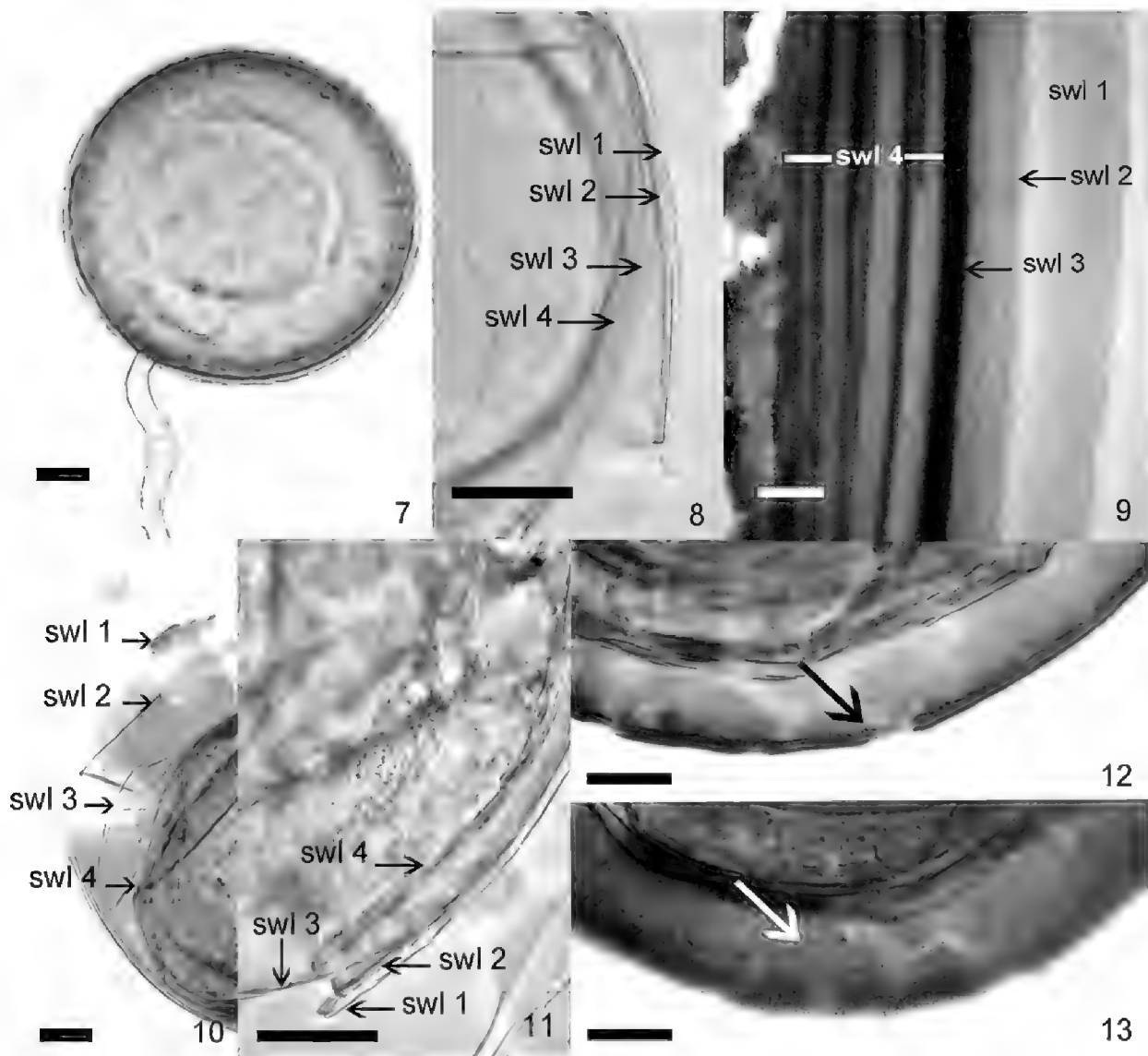
SUBTENDING HYPHA OF MATURE SPORES, single, cylindrical, 9.6–12.8 μm in diameter at the spore base, or slightly flared, 12.8–14.4 μm in diameter, concolorous to spore wall. WALL OF SUBTENDING HYPHA, 3.2–4.8 μm thick at spore base, made of the 3–4 spore wall layers, SWL 1 thinning within the first 5–10 μm from the spore. Pore generally open, 1.5–2.6 μm wide, rarely closed by a curved septum made by the inner laminae of SWL 4.



FIGS 1–6. Extraradical juvenile spores differentiated in pot-cultures. 1. Globose spores with hyphal attachment. 2. Spore wall layers swl 1,2 and 3. 3. Spore wall layers 1,2 and 4, note clear lamination of swl 4, and regular electron dense layer (arrow) potentially referring to swl 3 of mature spores, not observable under light microscopy. 4. Globose and irregular shaped spores with mycelium, stained with Melzer's reactive. 5. Irregular shaped spore with subtending hyphae. 6. Spore wall layers 1,2 and 3 of irregular shaped spore.

FIGS 1,2,4,5,6. Differential interference contrast microscope (DIC). Legend: swl = spore wall layer. Bars = 20 μm . FIG. 3. transmission electron microscopy (TEM), Bar = 1 μm .

INTRARADICAL SPORES from pot cultures, differentiated in loose clusters that can deform root tissue, often disrupting the epidermal cells of root; spores pale yellow to yellowish brown, globose to subglobose, (68–)74–100(–156) μm diam., both juvenile and matures spores found in the same spore clusters. VESICLES (FIGS 14–15), pale yellow, ovoid to ellipsoid, 30–46 \times 60–72 μm in size. ARBUSCULES (FIGS 16–17) of Paris-type when cultivated on leek, clover

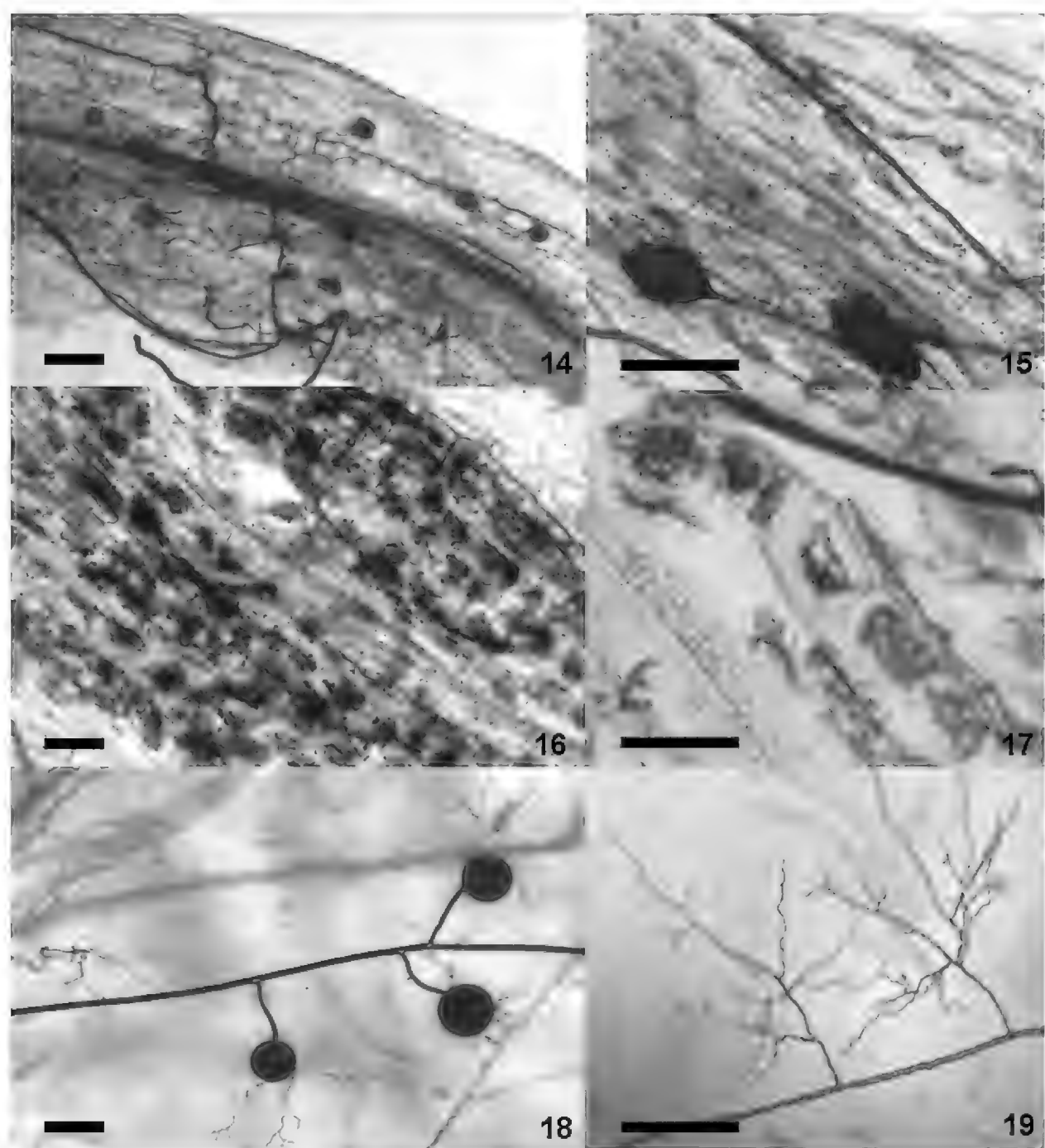


FIGS 7–13. Extraradical mature spores differentiated in pot-cultures: 7. Spore with hyphal attachment. 8. Spore wall layers swl1 to 4, mounted in water. 9. Spore wall layers swl 1–4, with different gradient density of swl 1 and 2, electron dense swl 3 and lamination of swl 4. 10. Crushed spore stained with Melzer's reagent with non-reactive swl 2 and 3, red staining of swl 1, dark red staining of swl 4. 11. Crushed spore mounted in PVLG with distinct 4 wall layers, inner ornamentation of swl 2 (arrow). 12–13. Spore wall layers stained with Cotton Blue, ornamentation of swl 2 (arrow).

FIGURES 7,8,10,11,12,13. Differential interference contrast microscope (DIC). Legend: swl = spore wall layer. Bars = 20µm. FIG. 9. Transmission electron microscopy (TEM), Bar = 1µm.

and carrot, often differentiated cell to cell, made of arbusculate coils of deformed hyphae, 3–8 µm diam.

IN VITRO COLONY ARCHITECTURE: mycelium made of runner hyphae, 8–12 µm in diameter, sparsely ramified at 45 to 90° angles, 1.4–2.0 µm wall thickness, slightly reactive to Melzer's reagent, ornamented with wart-like excrescences. Branched absorbing structures (BAS, Figs 18–19) located along hyphal ramifications often associated with spore differentiation. Life cycle, from spore germination to differentiation of germinative spores, takes three to four months,



FIGS 14–19. Figures 14–17: Fungal structures inside colonized roots. 18–19: Detailed of branching absorbing structures (BAS). 14. Entry points and vesicles along a colonized root, 15. Vesicles. 16. Arbuscular massive root colonization, 17. Arbusculate coils of Paris-type. 18. Spores of the fungal colony formed singly in association with BAS. 19. BAS with well developed branching pattern. Bars = 100µm.

followed by 6–9 months spore maturation process. It comprises an absorptive phase, with ERM covered by BAS, a transition absorptive to sporulative phase, with sporulation starting from the older parts of the fungal colony (closer to the host root) and a sporulative phase with the differentiation of up to 800 spores per cm³ of gel media.

MYCORRHIZAL ASSOCIATION. Vesicular-arbuscular mycorrhizae formed in pot and in vitro cultures. Field samples from which this species derived had originally

been collected from rhizosphere of a plant consortia consisting of Asteraceae (*Chamaemelum* sp., *Carduus* sp., *Chrysanthemum* sp.), Boraginaceae (*Echium* sp.), Cistaceae (*Cistus* sp.) and Poaceae (*Avena* sp.). In monoxenic culture grown on minimal "M" medium (Chabot et al. 1992) a mean root colonization of 42.0% ($\pm 21.8\%$) was found after 6 weeks of culturing. In greenhouse pot cultures the sp. nov. is maintained with *Allium porrum*, and *Trifolium pratense* L.

PHYLOGENETIC POSITION. The 18S sequence analysis of *Glomus custos* clustered in group A of *Glomeraceae* described by Schüssler et al. (2001) with 99.6% homology with the sequence of *G. intraradices* DAOM 197198. Bayesian sequence analysis of the ITS gene that complements the molecular data is presented as a phylogenetic tree (FIG. 20). The *G. custos* clone ITS sequences group together in a cluster clearly separated from the *G. intraradices* sequence, as indicated by the bootstrap values, with *G. diaphanum* J.B. Morton & C. Walker 1984, the closest related species, grouping on a different branch. When comparing ITS sequence data, the similarity between *G. custos* and *G. diaphanum* reached 82% and Blast alignment indicated between 89 and 97% similarity with an as yet uncultured *Glomus* sp., supporting the status of *G. custos* as a distinct species.

SPECIMENS EXAMINED. SPAIN: Rio Tinto, Huelva (pot culture inoculated with soil sample). **HOLOTYPE:** GDA 51.596; **ISOTYPES:** GDA 51.597, DAOM 236361, MUCL 47214, consisting of juvenile and mature spores mounted in PVLG and Melzer's reagent.

OTHER SPECIMENS EXAMINED. *Glomus aggregatum* N.C.Schenck & G.S.Sm. emend. Koske 1985 (OSC 40250), *G. claroideum* (OSC 40252), *G. gibbosum* Blaszk. 1997 (Blaszkowski collection 10/2051), *G. intraradices* (DAOM 197198),

DISTRIBUTION AND HABITAT. Originating from a single site at Rio Tinto, Huelva, Spain, 37°42'N/6°36'W, isolated from a pot culture established with rhizospheric soil originating from Rio Tinto, Huelva, altitude 380 m. a. s. l., a dry Mediterranean climate with mean temperatures fluctuating between 17°C in winter and 26°C in summer, and mean annual rainfall of 800 to 900 mm. The rhizospheric soil came from the bank side of the Rio Tinto River, a natural/anthropogenic degraded ecosystem located in a pyritic belt that confers to water and soil a pH of 2 and huge concentrations of Fe (2g/L), Mg (1.3g/L), Cu (390 mg/L), Zn (280 mg/L) and Mn (100 mg/L) amongst other heavy metals. Open-air mines of silver and other appreciated metals have been exploited in the vicinity for 5,000 years, resulting in a highly degraded landscape.

Discussion

Under the dissecting microscope, juvenile spores of *G. custos* closely resemble the spores of *G. aggregatum*, *G. claroideum*, *G. intraradices*, *G. gibbosum* and

G. irregulare Błasz. et al. 2008 in their hyaline to pale yellow pigmentation, spore diameter range, and hyphal attachment. Under light microscopy, *G. custos* juvenile spores clearly exhibit three spore wall layers that correspond respectively to a mucilaginous evanescent SWL 1, a rigid SWL 2, and the laminated SWL 4 of the mature spores (FIGS 2–3). Similarly as in *G. custos*, the internal spore wall layer of *G. irregulare* is laminated and highly reactive to Melzer's reagent. However, contrary to *G. irregulare*, the outer wall layer (SWL 1) of *G. custos*, is reactive to Melzer's and the middle wall layer (SWL 2) consists of a rigid wall contrary to the semi-permanent, disintegrating one of *G. irregulare*.

The pyriform to tuberculate spores of *G. custos* (FIGS 4–5) differentiate occasionally and only in pot cultures (never in monoxenic in vitro cultures). They closely resemble the irregular shaped spores produced by strains of *G. aggregatum* (Koske 1985, Dalpé 1985) and *G. irregulare* (Błaszowski et al. 2008). In fact, most *G. custos* spores are globose to subglobose while the majority of *G. irregulare* spores are irregular and rarely globose. Even though differentiated in clusters together with mature globose spores, their spore wall consistently remained 3-layered (FIG. 6). As such, when mature globose spores are absent, these irregularly shaped spores may be confused with those differentiated by *G. aggregatum* and *G. irregulare*. Segregation between species may then require adequate molecular tools. Similarly to *G. aggregatum* and *G. intraradices* species, spores of *G. custos* are often found hidden between thin vermiculite layers suggesting the flexibility of spore walls and the necessity for the fungus to adapt to the restricted space (C. Cano, pers. observation).

The main distinctive characteristics of mature *G. custos* spores are their unique 4-layered spore wall architecture, combined with the red dextrinoid reaction of SWL 1 and SWL 4 to Melzer's reagent (FIGS 7–11), a combined feature not found in any previously published species. Of the 4 wall-layered known *Glomus* spp. with similar spore size range and pigmentation, only *G. claroideum* and *G. gibbosum* spores share some similarity with those of *G. custos*. *Glomus claroideum* spore wall architecture is composed of an outer hyaline mucilaginous SWL 1 often absent in mature spores, slightly reactive with Melzer's and tightly adherent to a semi-flexible hyaline SWL 2, which is non reactive to Melzer's, an outside wall layer arrangement similar to the wall structure observed in juvenile and mature *G. custos* spores. Inner wall layers of *G. claroideum*, however, differ considerably from *G. custos* being made by the succession of a thick laminated wall non-reactive to Melzer's reagent and a flexible innermost layer (<http://www.agro.ar.szccecinagro.ar.szccecin.pl/~jblaszkowski/Glomus%20claroideum.html>). *Glomus gibbosum* and *G. claroideum* spores share similar spore wall architecture, except that no *G. gibbosum* wall layer reacts to Melzer's reagent. *Glomus aggregatum*, *G. intraradices*, and *G. irregulare* — all three-wall layered spores — lack the

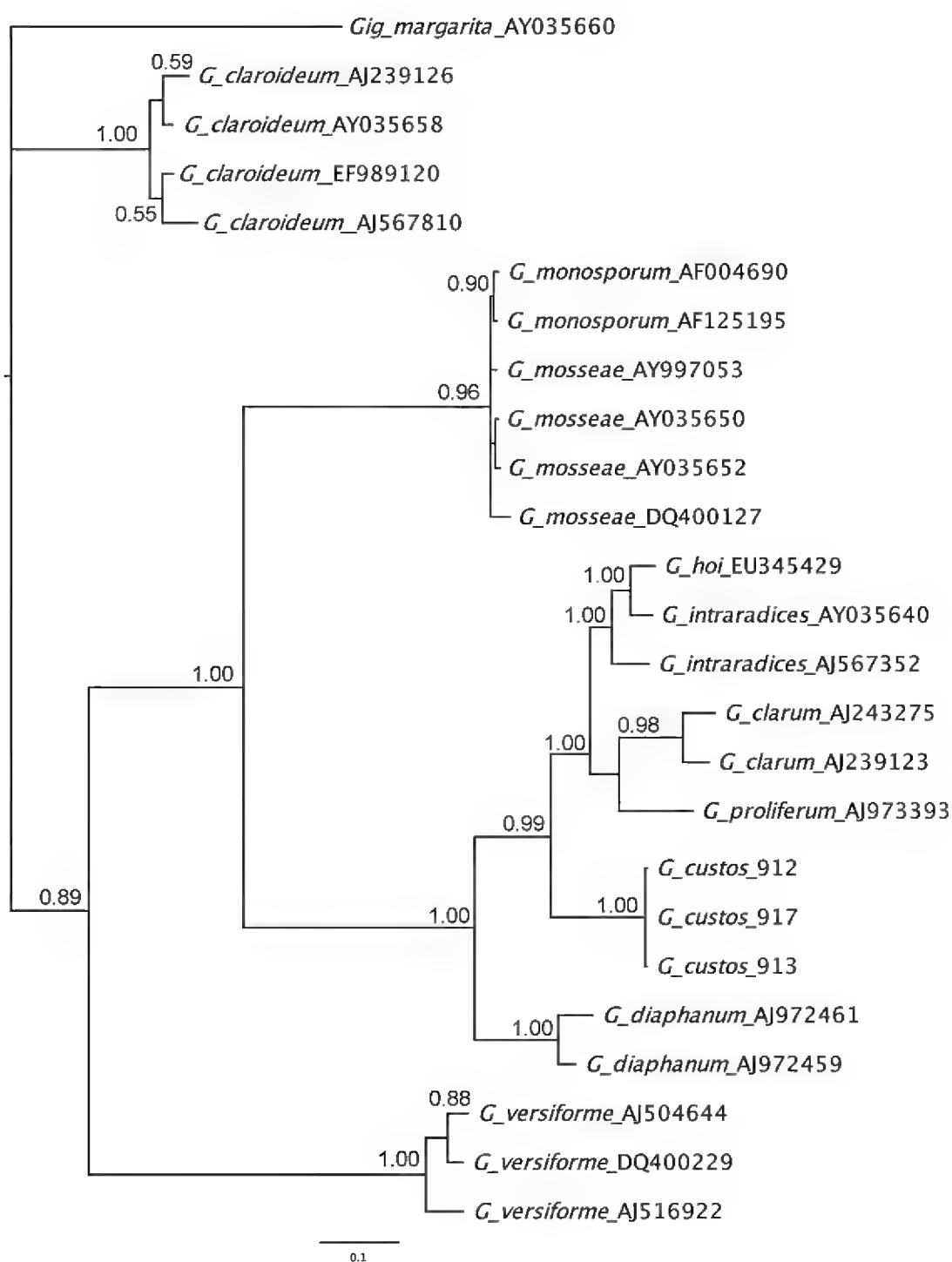


FIG. 20. Phylogenetic tree of rDNA sequences from *G. custos* and other *Glomus* species based on Bayesian analysis of ITS small ribosomal subunit sequences (497 basepairs) *Gigaspora margarita* used as outgroup. Numbers refer to bootstrap values from 1000 replications.

semi-flexible swL 3 clearly detectable in mature *G. custos* spores (FIGS 8–11), their maximum spore size overlaps the smallest *G. custos* spores, and (except for *G. irregulare*) the swL 3 laminated wall does not react in Melzer’s.

The unique spore wall architecture of mature *G. custos* spores allows its segregation from the other described *Glomus* species. However, juvenile

G. custos spores might be confused with spores of species having similar spore wall morphology. As both juvenile and mature spores usually occur together in clusters, the possible confusion should not deter successful identification. An additional *G. custos* spore morphological feature that is likely less valuable (because it occurs on only ~20% of the mature spores) is the granular inner surface ornamentation of SWL 2. This «accessory» feature is more easily detected on Cotton Blue and Melzer's stained crushed spores at high magnification (600×) (FIGS 12–13) and has been observed from both in vivo and in vitro propagated spores. In some mature spores, the inner laminae of SWL 4 may detach and could be interpreted as a separate membranous inner wall layer. Among the 5 wall-layered known *Glomus* species, *G. caesaris* Sieverd. & Oehl (Oehl et al. 2002) differentiates yellow-brown to brown spores with a granular outer wall layer and four successive inner layers (SWL 2–5), a wall architecture different from the one observed with *G. custos* spores.

Phylogenetic analyses of a partial DNA sequence of the 18S ribosomal small subunit gene using in vitro propagated *G. custos* spores place this new species into *Glomeraceae* group A, closely matching *G. intraradices* (DAOM 197198) with a 99.6% sequence similarity. As the species segregation potential of the 18S rDNA SSU gene remains limited, and because spore morphology and spore wall architecture of *G. custos* considerably diverge from those of *G. intraradices*, DNA sequencing of ITS small subunit gene were performed on the same fungal material to complement molecular phylogeny of the strain. ITS analyses revealed a 97% sequence similarity between *G. custos* and *G. intraradices* (DAOM 197198). As seen in FIG. 19, the Bayesian ITS phylogenetic tree clearly separates the *G. custos* clones from its closer related entity, *G. diaphanum*.

Traditional morphological taxonomy, multiple molecular tests, and in vitro propagation technique have allowed the isolation, description, and characterization of *G. custos* sp. nov.

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Literature cited

- Bago C, Azcón-Aguilar C, Piché Y. 1998. Architecture and developmental dynamics of the extraradical mycelium of the arbuscular mycorrhizal fungus *Glomus intraradices* grown under monoxenic conditions. *Mycologia* 90: 52–62.
- Bago A, Cano C, Samson J, Coughlan AP, Piché Y, Azcón-Aguilar C. 2004. Differential morphogenesis of the extraradical mycelium of an arbuscular mycorrhizal fungus grown monoxenically on spatially heterogeneous culture media. *Mycologia* 96: 452–462.
- Blaszkowski J, Czerniawska B, Wubet T, Schäfer T, Buscot F, Renker C. 2008. *Glomus irregulare*, a new arbuscular mycorrhizal fungus in the *Glomeromycota*. *Mycotaxon* 106: 247–267.
- Cano C, Bago A. 2006. Competition and substrate colonization strategies of three polyxenically grown arbuscular mycorrhizal fungi. *Mycologia* 97: 1201–1214.
- Cano C, Dickson S, González-Guerrero M, Bago A. 2008. In vitro cultures open new prospects for basic research in arbuscular mycorrhizas. In: *Mycorrhiza*. Third Edition. A Varma (Ed.). Springer, Berlin. pp. 627–654.
- Chabot S, Bécard G, Piché Y. 1992. Life cycle of *Glomus intraradix* in root organ culture. *Mycologia* 84: 315–321.
- Dalpé Y. 1985. *Glomus aggregatum*. Fungi Canadenses #299. National Mycological Herbarium, Research Branch, Agriculture and Agri-Food Canada.
- Declerck C, Cranenbrouck S, Dalpé Y, Séguin S, Grandmougin-Ferjani A, Fontaine J, Sancholle M. 2000. *Glomus proliferum* sp. nov.: a description based on morphological, biochemical, molecular and monoxenic cultivation data. *Mycologia* 92: 1178–1187.
- Doner LW, Bécard G. 1991. Solubilization of gellan gels by chelation of cations. *Biotechnology Techniques* 5: 25–28.
- Koske RE. 1985. *Glomus aggregatum* emended: a distinct taxon in the *Glomus fasciculatum* complex. *Mycologia* 77: 619–630.
- Li LF, Li T, Zhao ZW. 2007. Differences of arbuscular mycorrhizal fungal diversity and community between a cultivated land, an old field, and a never-cultivated field in a hot and arid ecosystem of southwest China. *Mycorrhiza* 17: 655–665.
- Oehl F, Wiemken A, Sieverding E. 2002. *Glomus caesaris*, a new arbuscular mycorrhizal fungus from the Kaiserstuhl in Germany. *Mycotaxon* 84: 379–385.
- Omar MB, Bolland L, Heather WA. 1979. A permanent mounting medium for fungi. *Bulletin of the British Mycological Society* 13: 31.
- Phillips JM, Hayman DS. 1970. Improved procedures for clearing roots and staining parasitic and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection. *Transactions of the British Mycological Society* 55: 158–160.
- Rambaut A. 1996. Se-Al. Sequence alignment editor. tree.bio.ed.ac.uk/software/
- Ronquist F, Huelsenbeck JP. 2003. MRBAYES 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics* 19: 1572–1574.
- Schüssler A, Schwarzott D, Walker C. 2001. A new fungal phylum, the *Glomeromycota*: phylogeny and evolution. *Mycological Research* 105: 1413–1421.
- Sieverding E. 1991. Vesicular-arbuscular mycorrhiza management in tropical agrosystems. GTZ Eschborn, Germany. 371 pp.
- Simon L, Levesque RC, Lalonde M. 1993. Identification of endomycorrhizal fungi colonizing roots by fluorescent single-strand conformation polymorphism polymerase chain-reaction. *Applied and Environmental Microbiology* 59: 4211–4215.
- Stürmer SL, Morton JB. 1997. Developmental patterns defining morphological characters in spores of four species in *Glomus*. *Mycologia* 89: 72–81.

- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The Clustal_X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* 25: 4876–4882. doi:10.1093/nar/25.24.4876. PMID:9396791.
- Trouvelot A, Kough JL, Gianinazzi-Pearson V. 1986. Mesure du taux de mycorhization VA d'un système racinaire. Recherche de methods d'estimation ayant une signification fonctionnelle. In: *Physiological and genetical aspects of mycorrhizae*. V Gianinazzi-Pearson, S Gianinazzi (Eds). Paris: INRA. pp. 217–221.
- Walker C. 1983. Taxonomic concepts in the *Endogonaceae*: Spore wall characteristics in species descriptions. *Mycotaxon* 18: 443–455.
- White TJ, Bruns TD, Lee SB, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA Genes for phylogenetics. In: *PCR – protocols and applications – a laboratory manual*. N Innis, D Gelfand, J Sninsky, T White (Eds). Academic Press, New-York. pp. 315–322.

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- Castañeda Ruiz, Rafael F., Luis Fernando Pascholati Gusmão, Alisson C. Rodrigues da Cruz, Gabriela Heredia Abarca, Teresa Iturriaga, Josep Guarro, Masatoshi Saikawa, Marc Stadler & David W. Minter. *Phaeocandelabrum*, a new genus of anamorphic fungi to accommodate *Sopagraha elegans* and two new species, *Ph. callisporum* and *Ph. joseiturriagae*. 109: 221–232. 2009.
- Castañeda Ruiz, Rafael F., Luis Fernando Pascholati Gusmão, Venício Oliveira De Moraes Júnior, Sheila Miranda Leão-Ferreira, Masatoshi Saikawa, David W. Minter & Marc Stadler. Two setose anamorphic fungi: *Ampullicephala* gen. nov. and *Venustosynnema grandiae* sp. nov.. 109: 275–288. 2009.
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- Goto, Bruno Tomio, Leonor Costa Maia, Gladstone Alves da Silva & Fritz Oehl. *Racocetra intraornata*, a new species in the *Glomeromycetes* with a unique spore wall structure. 109: 483–491. 2009.
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- Hawksworth, David L., Victor J. Rico, José María Barrasa & Jana Kocourková. On the identity of Velenovský's *Cantharellus peltigerae*. 109: 315–318. 2009.
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- Kinalioğlu, Kadir. Lichens from the Amasya, Çorum, and Tokat regions of Turkey. 109: 181–184. 2009.
- Kirschner, Roland & Franz Oberwinkler. Supplementary notes on *Basidiopycnis hyalina* (*Basidiomycota*, *Atractiellales*) and its anamorph. 109: 29–38. 2009.
- Knudsen, Kerry, see Halici & al.
- Kocourková, Jana, see Hawksworth & al.
- Krzewicka, Beata & Karina Wilk. *Umbilicaria isidiosa* (lichenized *Ascomycota*), a new species from Bolivia. 109: 165–170. 2009.
- Kukwa, Martin, see Zhurbenko & al.
- Kumar, T.K. Arun & P. Manimohan. Rediscovery of *Trogia cyanea* and a record of *T. infundibuliformis* (*Marasmiaceae*, *Agaricales*) from Kerala State, India. 109: 429–436. 2009.
- Kunwar, I.K., see Bagyanarayana & al.
- Larsson, Ellen, see Jacobsson & Larsson
- Leão-Ferreira, Sheila Miranda, see Castañeda Ruiz & al.
- Li, Ming Jiang, see Zhang & Li
- Li, Shifu, Zefen Yu, Ying Zhang, Min Qiao, Jianwei Guo & Keqin Zhang. *Arthrobotrys nonseptata*, a new anamorph from an *Orbilia* species. 109: 247–254. 2009.
- Li, Tai-Hui, Xiang-Lian Chen, Ya-Heng Shen & Ting Li. A white species of *Volvariella* (*Basidiomycota*, *Agaricales*) from southern China. 109: 255–261. 2009.

- Li, Tai-Hui, see Shen & al.
- Li, Ting, see Li & al.
- Li, Yu, see Vasilyeva & al.
- Liang, Jiandong, see Han & al.
- Liang, Zongqi, see Han & al.
- Liu, Pei-Gui, see Deng & al.
- Liu, Tiezhi & Uwe Braun. Taxonomic notes on some powdery mildews from Inner Mongolia. 109: 21–27. 2009.
- Llop, Esteve & Peter van den Boom. Notes on the lichen genus *Bacidia* s.l. (lichenized *Ascomycota*) in the Cape Verde Islands and new lichen records for the archipelago. 109: 171–179. 2009.
- Loguercio-Leite, Clarice, see Trierveiler-Pereira & al.
- Lu, Chunxia & Lin Guo. *Septobasidium maesae* sp. nov. (*Septobasidiaceae*) from China. 109: 103–106. 2009.
- Lu, Chungxia & Lin Guo. Two new species of *Septobasidium* (*Septobasidiaceae*) from China. 109: 477–482. 2009.
- Lumbsch, H. Thorsten & Khwanruan Papong. *Ocellularia gyrostromoides* belongs to the genus *Schizoxylon* (*Stictidaceae*, *Ascomycota*). 109: 319–322. 2009.
- Maia, Leonor Costa, see Goto & al.
- Makhija, Urmila, Gayatri Chitale & Bharati Sharma. New species and new records of *Diorygma* (*Graphidaceae*) from India: species with convergent exciples. 109: 379–392. 2009.
- Makhija, Urmila, see Sharma & Makhija
- Manimohan, P., see Kumar & Manimohan
- Marcelli, Marcelo Pinto, Patrícia Jungbluth & John A. Elix. Four new species of *Punctelia* from São Paulo State, Brazil. 109: 49–61. 2009.
- Martín, J., see Platas & al.
- Martín, María P. & Miguel A. García. How many species in the *Rhizopogon roseolus* group? 109: 111–128. 2009.
- McKenzie, Eric H.C. A new species of *Lylea* (hyphomycetes) on *Rhopalostylis* (*Arecaceae*) in New Zealand. 109: 39–42. 2009.
- Melo, I., see Telleria & al.
- Melo, Ireneia, see Dueñas & al.
- Minnis, Andrew M., Gary J. Samuels & Priscila Chaverri. Three nomenclatural corrections for species of *Hypocrea*/*Trichoderma*. 109: 245–246. 2009.
- Minter, David W., see Castañeda Ruíz & al.
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- Pei, Yun-Fei, Yun Geng, Yong Wang & Xiu-Guo Zhang. Two new species of *Stemphylium* from Sinkiang, China. 109: 493–497. 2009.
- Peláez, F., see Platas & al.
- Platas, G., V. González, J. Collado, J. Martín, C. Montes & F. Peláez. Ascription of poorly defined taxa to taxonomic entities using molecular phylogenies: a case study on *Nodulisporium* sp. producers of nodulisporic acid. 109: 443–460. 2009.
- Qiao, Min, see Li & al.
- Rao, N. Krishna, see Bagyanarayana & al.
- Reck, Mateus A. & Rosa Mara Borges da Silveira. *Grammothele* species from southern Brazil. 109: 361–372. 2009.
- Rico, Victor J., see Hawksworth & al.
- Roberts, Peter. *Exidia nigricans*: a new and legitimate name for *Exidia plana*. 109: 219–220. 2009.
- Rodríguez-Armas, J.L., see Telleria & al.
- Saikawa, Masatoshi, see Castañeda Ruiz & al.
- Saitta, Alessandro, Maria Letizia Gargano & Giuseppe Venturella. *Elaphomyces citrinus* and *Elaphomyces maculatus* in Sicily (Southern Italy). 109: 269–274. 2009.
- Salcedo, I., see Telleria & al.
- Samuels, Gary J., see Minnis & al.
- Sharma, Bharati & Urmila Makhija. New species and new reports of *Diorygma* (lichenized Ascomycotina, Graphidaceae) from India. 109: 209–217. 2009.
- Sharma, Bharati, see Makhija & al.
- Shen, Ya-Heng, Dong-Mei Wang, Tai-Hui Li & Bin Song. *Ceratomyces hyalinus*, a new species from China. 109: 347–349. 2009.
- Shen, Ya-Heng, Dong-Mei Wang, Tai-Hui Li & Bin Song. Two new records of the genus *Laboulbenia* from China. 109: 341–345. 2009.
- Shen, Ya-Heng, see Li & al.
- Silva, Gladstone Alves da, see Goto & al.
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- Song, Bin, see Shen & al.
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- Stephenson, Steven, see Vasilyeva & al.
- Stoykov, Dimitar Y. & Boris Assyov. The genus *Trochila* in Bulgaria. 109: 351–359. 2009.
- Sultan, A., see Iqbal & al.
- Sun, Guangyu, see Zhang & al.
- Tang, Ming, see Zhang & al.
- Telleria, M.T., I. Melo, M. Dueñas, I. Salcedo, J. Cardoso, J.L. Rodríguez-Armas & E. Beltrán-Tejera. Corticioid fungi (*Basidiomycota*) from the Azores Islands: Flores and São Miguel. 109: 141–144. 2009.
- Telleria, M. Teresa, see Dueñas & al.
- Trierveiler-Pereira, Larissa, Juliano Marcon Baltazar & Clarice Loguercio-Leite. Santa Catarina Island mangroves 4 – xylophilous basidiomycetes. 109: 107–110. 2009.

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Wu, Yue-Ming, Yue-Hua Geng & Tian-Yu Zhang. Three new species of *Monodictys* from soil. 109: 263–267. 2009.

Yáñez-Ayabaca, Alba & Sionara Eliasaro. *Hypotrachyna carchiensis*, a new species in the *Parmeliaceae* from Ecuador. 109: 337–340. 2009.

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Yu, Zefen, see Li & al.

Zhang, Jing Ze & Ming Jiang Li. A new species of *Bipolaris* from the halophyte *Sesuvium portulacastrum* in Guangdong Province, China. 109: 289–300. 2009.

Zhang, Kai, Hong-Bo Fu & Xiu-Guo Zhang. Taxonomic studies of *Corynespora* from Hainan, China. 109: 85–93. 2009.

Zhang, Kai, Hong-Bo Fu & Xiu-Guo Zhang. Taxonomic studies of *Minimelanolocus* from Yunnan, China. 109: 95–101. 2009.

Zhang, Keqin, see Li & al.

Zhang, Meng & Tian-Yu Zhang. Taxonomic studies of *Helminthosporium* from China 4. Six new species and a key to *Helminthosporium* from China. 109: 399–413. 2009.

Zhang, Rong, Xupeng Guo, Guangyu Sun, Ming Tang & Mark L. Gleason. *Dothiorella viticola* on *Populus cathayana* in China: a new record. 109: 129–135. 2009.

Zhang, Tian-Yu, see Wu & al.

Zhang, Tian-Yu, see Zhang & Zhang

Zhang, Xiu-Guo, see Zhang & al.

Zhang, Yanwei, see Han & al.

Zhang, Ying, see Li & al.

Zhang, Xiu-Guo, see Pei & al.

Zhuang, Wen Ying. The genus *Sowerbyella* (*Pezizales*) in China by Wen-Ying Zhuang. 109: 233–237. 2009.

Zhurbenko, Mikhail P., Martin Kukwa & Magdalena Oset. *Roselliniella stereocaulorum* (*Sordariales*, *Ascomycota*), a new lichenicolous fungus from the Holarctic. 109: 323–328. 2009.

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VOLUME 96

p. 142, line 134	for: <i>Lecanora flotowiana</i>	read: <i>Lecanora flotoviana</i>
p. 144, line 17, col. 2	for: <i>Lecanora flotowiana</i>	read: <i>Lecanora flotoviana</i>

VOLUME 97

p. 294, line 7	for: <i>L. flotowiana</i>	read: <i>L. flotoviana</i>
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VOLUME 108

p. 518, 2nd line after Volume 101 IGNORE correction for: *B. kowhai*
NOTE: the entry on p. 317, line 12 in volume 101 was an intentional correction of an error made in the recombination (Schroers, Stud. Mycol. 46: 69). *Bionectria kowhai* is correct; Joan Dingley's epithet is a non-declinable Maori noun in apposition.

FROM THE *EDITOR-IN-CHIEF*

MYCOTAXON 109 — Welcome to the July–September volume, containing 65 papers by 190 authors and co-authors and introducing 83 new scientific names. Although our submissions are at an all-time high, we are gradually decreasing the average turn-around time from final submission to publication to less than three months. Page 487 offers another stunning color photo; authors who cannot afford to pay for print journal publication of color plates are reminded to contact the EDITOR-IN-CHIEF during final submission if they wish to obtain a separate PDF with color images for web use for a \$40 fee.

Seven new annotated species lists have been added to the 57 downloadable PDFs posted on Mycotaxon's regional checklist webpage [WWW.MYCOTAXON.COM/RESOURCES/WEBLISTS.HTML]. Two incorporate a special bonus: Trierveiler & al. offer line drawings of important microcharacters for 21 xylophilous basidiomycete species associated with Santa Catarina Island (Brazil) mangroves and Gorjón & al. include drawings of microelements and full color basidiome photos of seven notable new or rare species in their enumeration of corticioid fungi from the Las Bateucas-Sierra de Francia (Spain).

We wish to take this opportunity to thank the 103 experts (including external reviewers consulted by the Editors when questions still remain) who helped authors deliver scientifically accurate and well-written manuscripts. We ask that all authors acknowledge their experts in their acknowledgments to reflect the extra attention MYCOTAXON asks of its reviewers. Our reviewer list (see p. 523) also honors experts consulted by the Editors during final editorial review as well as those who review manuscripts that are ultimately withdrawn or rejected.

AUTHOR INSTRUCTIONS TO BE UPDATED FOR 2010 — The current author instructions are scheduled for a [very!] slight modification to accommodate small editorial changes that have accumulated since the 2007 November revision. The submission process (see next page) remains unchanged. We shall modify our sample manuscript to reflect minor formatting changes (e.g., using 'small caps' instead of bold within paragraphs and identity/equality symbols in nomenclators) and other items now handled during nomenclatural and final editorial reviews. Additionally, we will ask that authors submit their art files in jpg format to decrease file sizes during final submission. The new instructions will be available on our website sometime in October 2009.

BOOK REVIEW EDITORS — Beginning in 2010, we will expand our book review staff by at least one in an effort to include book reviews in every volume. We have yet to work out the logistics, but Dr. ELSE VELLINGA has agreed to serve as Book Review Editor for the *Basidiomycota*. Prof. DAVID HAWKSWORTH will supply his usual reviews for our October–December volume, MYCOTAXON 110. Stay tuned for more information!

Warm regards,

Lorelei L. Norvell,
MYCOTAXON *Editor-in-Chief*
26 August 2009

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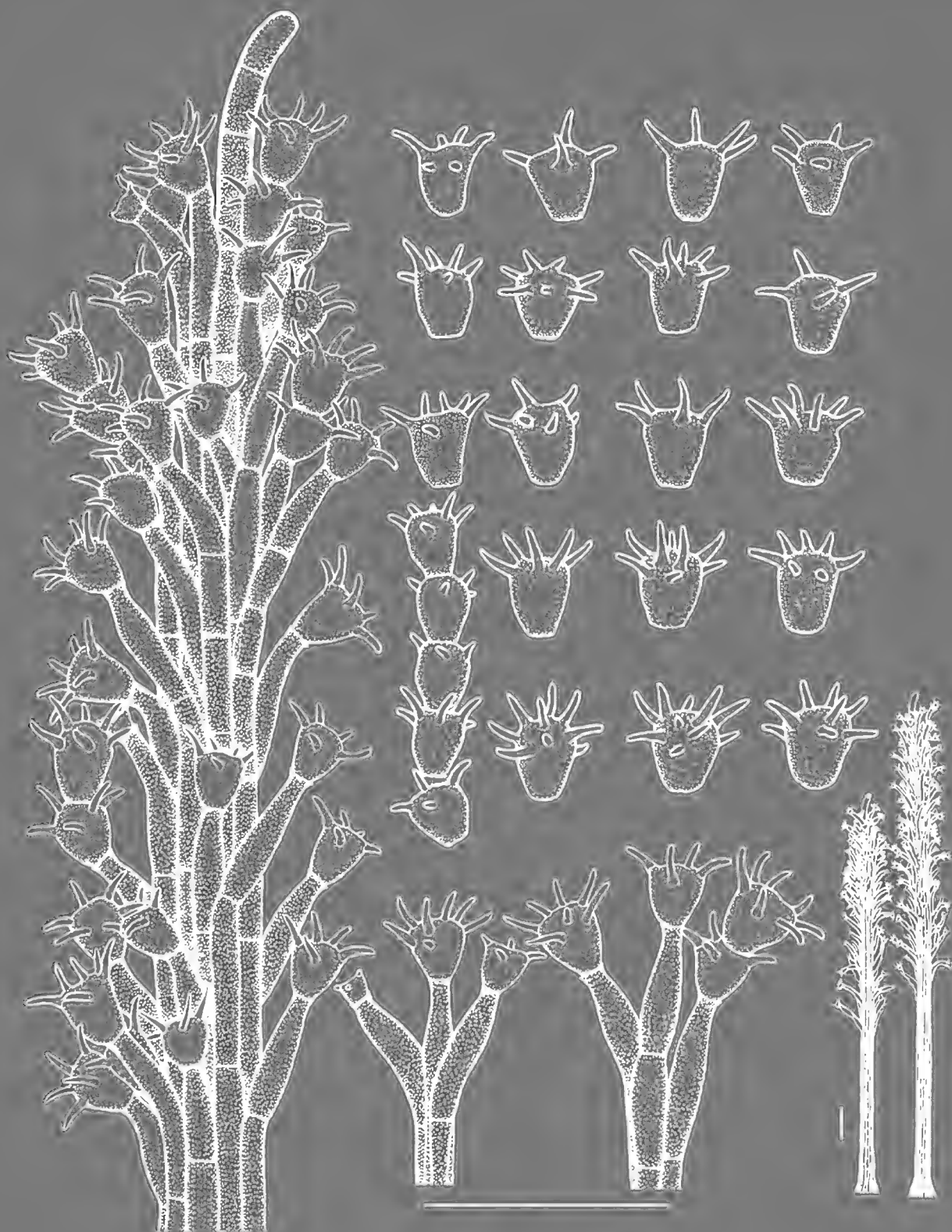
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MYCOTAXON

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VOLUME 110

OCTOBER–DECEMBER 2009



WU & ZHANG

Phialosporostilbe yadongensis sp. nov.

(p. 2)

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New species of *Phialosporostilbe* and *Pleurothecium* from soil

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Abstract — Two new species of dematiaceous hyphomycetes from soil in China, *Phialosporostilbe yadongensis* and *Pleurothecium clavatum*, are described and illustrated. The type specimens (dried cultures) and living cultures are deposited in the Herbarium of Shandong Agricultural University Plant Pathology (HSAUP). Isotypes are kept in the Herbarium of the Institute of Microbiology, Academia Sinica (HMAS).

Key words — taxonomy, soil fungi

Introduction

Since Mercado & Mena (1985) erected *Phialosporostilbe* for *P. turbinata* Mercado & J. Mena, four species have been recognized worldwide. This genus has distinctive synnematal conidiomata; integrated, annellidic or monophialidic conidiogenous cells on the apical portion of the synnema; and conidia that are acrogenous, phialidic, catenate, cuneiform, or turbinate, colourless to pale brown, amerosporous, and smooth, and have short subapical appendages. *Pleurothecium* Höhn. was erected in 1919, and six species have been recognized worldwide. The conidia, which arise in a sympodial sequence on distinct denticles, are single, didymosporous, frequently fusiform, ellipsoidal or clavate, smooth, and pale brown to brown. During a recent survey of soil hyphomycetes in China, new species of *Phialosporostilbe* and *Pleurothecium* were found.

Taxonomic descriptions

Phialosporostilbe yadongensis Y.M. Wu & T.Y. Zhang, sp. nov.

FIGURE 1

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Coloniae effusae, piliformes, albae ad griseo-brunneae. Conidiomata synnemata, erecta, 200–720 µm alt. ex conidiophoris parallelis, contiguis, septatis, brunneis, apice fertili divergentibus, composita. Synnemata semper unisetis, sterilia, atrobrunneis, laevia,

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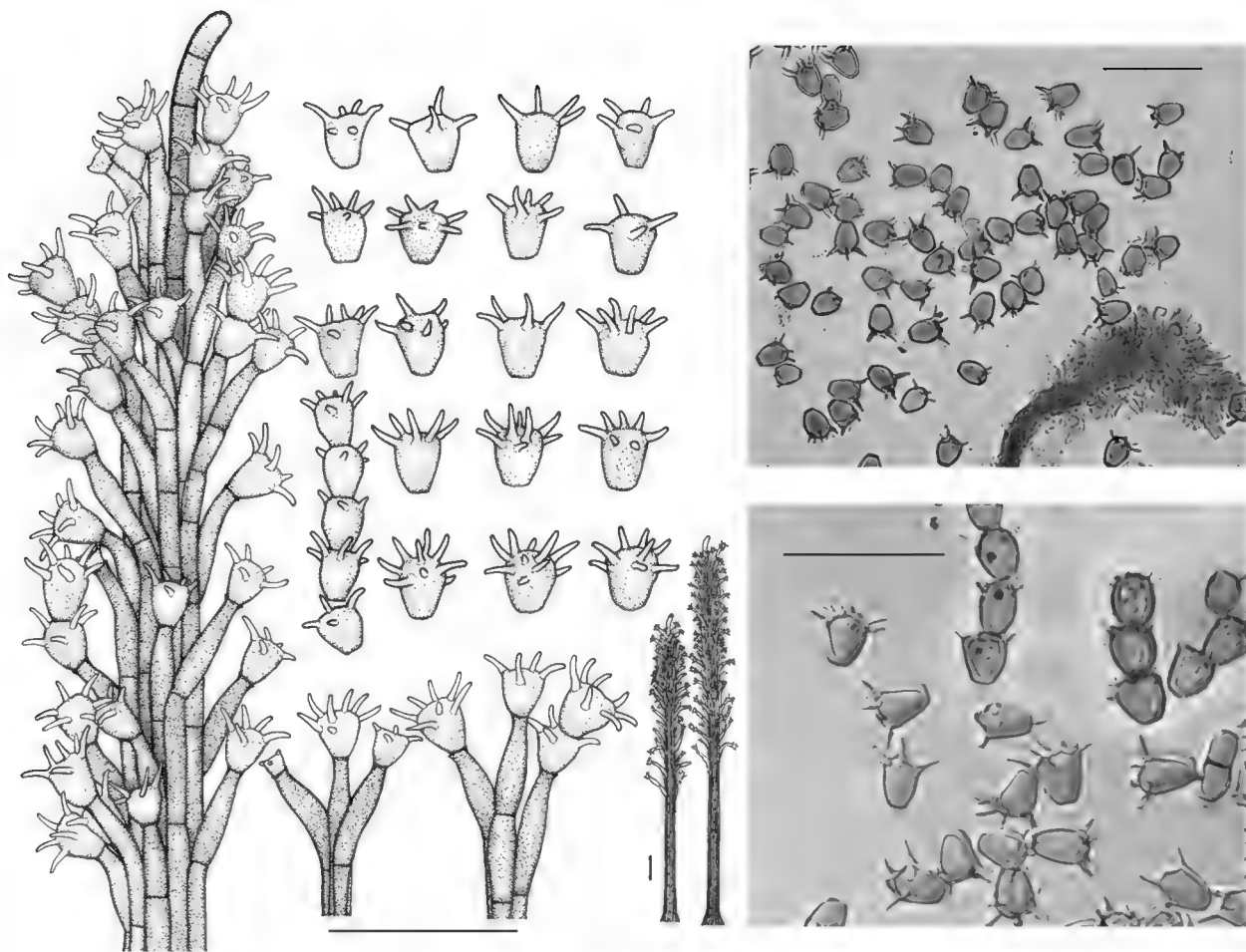


FIG. 1 Conidia, conidiogenous cells and synnemata of *Phialosporostilbe yadongensis* (ex holotype; bar = 25 μ m); left: drawings; right: photomicrographs.

crassitunicatis, *obtusis*, 220–730 μ m *alta*. *Cellulae conidiogenae terminales*, *ex axibus synnematis*, *divergentes*, *pallide brunneae vel modice brunneae*. *Conidia phialidica*, *amerospora*, *catenata*, *usque ad 10 per catena*, *cuneiformia*, *non-septata*, *pallide brunnea*, 6–8.5 μ m *longa*, *cum 4–10 appendiculatis*, 4–7 μ m *longa*.

HOLOTYPE: from a grassland soil of Yadong, Tibet, China, altitude 3400m. Sept. 11. 2007, Y.M. Wu, HSAUPII₀₇1114, holotype; HMAS 196250, isotype.

ETYMOLOGY: The epithet refers to the type location.

Colonies on PDA 25°C effuse, hairy, grayish brown. Conidiomata synnematal, straight, 200–720 μ m tall, 10–25 μ m wide at base, 8–18 μ m at the apex, composed of one dark brown, central seta and 10–20 parallel, thick-walled, septate, brown conidiophores diverging at their fertile apices, synnemata indeterminate incorporating 1 sterile seta, dark brown, smooth, thick-walled, blunt, 220–730 μ m long, 6–9 μ m wide. Conidiogenous cells terminal, integrated, monophialidic, pale brown to medium brown, cylindrical, 20–50 μ m long, 3–5 μ m wide at the tip, with an inconspicuous apical collarette. Conidia phialidic, amerosporous, catenate, up to 10 in a chain, cuneiform, with 4–10 radiating subapical appendages and a slightly truncate to rounded narrow base, non-septate, thick-walled, smooth, base truncate, pale brown, 6–8.5 μ m long, 6–8 μ m at the widest region, appendages 4–7 μ m long.

This fungus somewhat resembles *Phialosporostilbe catenata* Sureshk. et al. (Sureshkumar et al. 2005) in conidial morphology. But the latter has larger ($12.3\text{--}15.2 \times 7.4\text{--}10\text{ }\mu\text{m}$), colourless conidia, with only two appendages.

Pleurothecium clavatum Y.M. Wu & T.Y. Zhang, sp. nov.

FIGURE 2

MYCOBANK MB 513017

Coloniae in PDA effusae. Mycelium partim superficiale et partim in substrato, ex hyphis ramosis septatis, subhyalinis vel pallide brunneae, 2–4 μm crassis composita. Conidiophora simplicia, cylindrica, 15–40 μm longa, 2–3 μm crassa, continua vel septata, flexuosa, laevigata, brunnea. Cellulae conidiogenae in conidiophoris connatae, sympodiales, polyblasticae vel monoblasticae, cylindricae, denticulatae. Conidia singularia, acropleurogena, clavata, pallide brunnea, laevigata, continua vel uniseptata, 15–32 μm longa, 3–4 μm crassa, basin clavatis protrudentibus dentes.

HOLOTYPE: from a mountain soil of Changzhi, Shanxi Province, China, altitude 1500m. Sept. 16. 2004, Y.M. Wu, HSAUPII₀₄1183, holotype; HMAS 196251, isotype.

ETYMOLOGY: The epithet refers to the clavate conidia of this species.

Colonies on PDA after two weeks at 25°C, effuse, growing very slowly reaching a diameter of 2–3 cm, centre slightly raised, velvety, olivaceous brown. Mycelium partly superficial, partly immersed. Hyphae pale to mid brown, smooth, septate, 2–4 μm thick. Conidiophores simple, straight or flexuous, pale to mid brown, septate, 15–40 μm long, 2–3 μm thick, sympodial, denticulate. Conidia solitary,

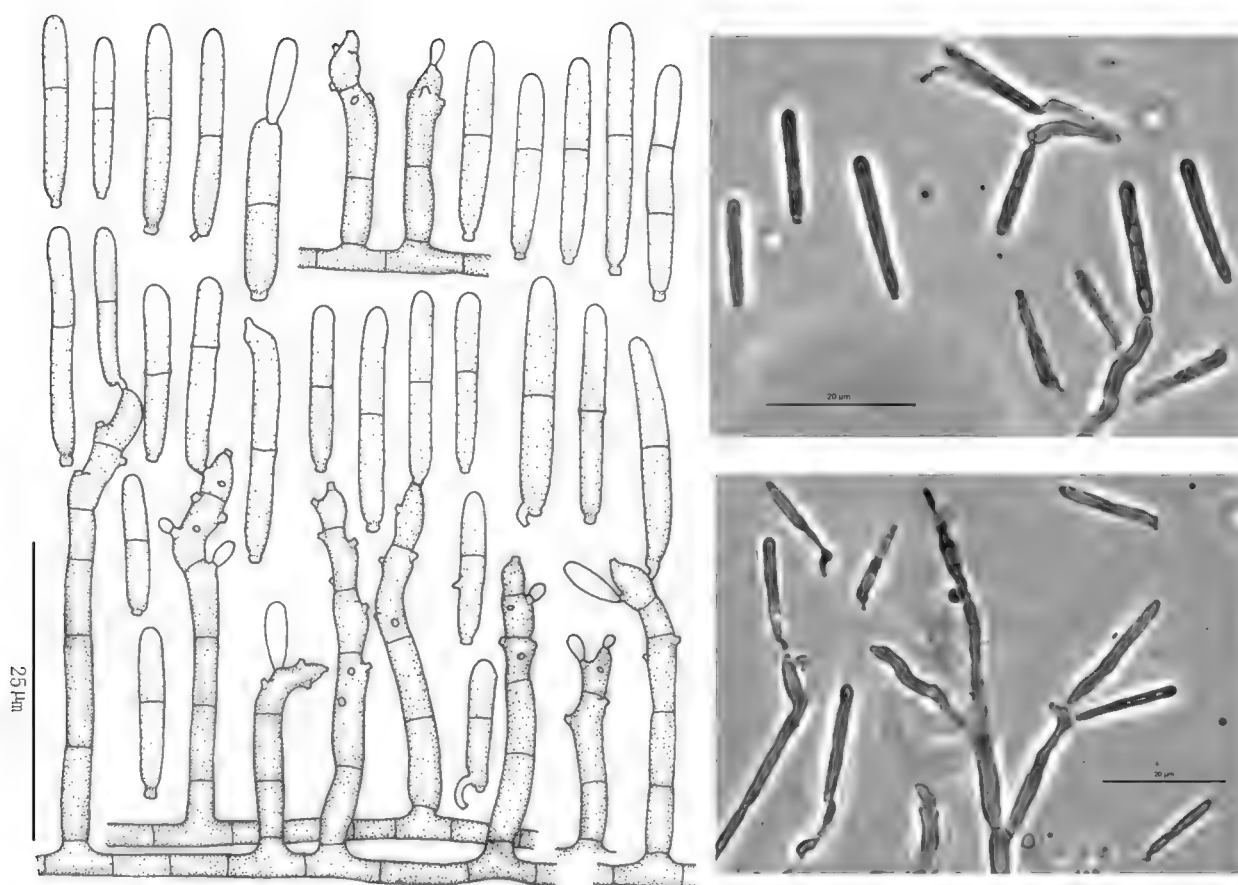


FIG.2 Conidia and conidiophores of *Pleurothecium clavatum* (ex holotype; bar = 25 μm); left: drawings; right: photomicrographs.

straight or slightly curved, mostly clavate, 1–2 (usually 1)-septate, pale brown, smooth, $15\text{--}32 \times 3\text{--}4 \mu\text{m}$, sometimes with a small protuberant peg at the base.

This fungus somewhat resembles *Pleurothecium malayaense* K. Matsush. & Matsush. (Matsushima 1996) in conidium morphology. But the conidia of the latter are shorter and narrower ($14\text{--}21 \times 1.5\text{--}2.0 \mu\text{m}$) than those of *P. clavatum*.

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Literature cited

- Matsushima T. 1996. Matsushima Mycological Memoirs No.9. 1–40 + plates.
Mercado Sierra A, Mena Portales J. 1985. Nuevo género de hifomicete fialídico de Cuba. Rev. Jardín Bot. Nac. Univ. Habana Cuba 6: 57–60.
Sureshkumar G, Sharath Babu K, Kunwar IK, Manoharachary C. 2005. Two new hyphomycetous fungal species from India. Mycotaxon 92: 279–283.

Contributions to a revision of the genus *Cercidospora* (*Dothideales*) 1. Species on *Megasporaceae*

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Abstract — A study on the taxonomy, morphology and anatomy of lichenicolous species of the genus *Cercidospora* (*Dothideales*, incertae sedis) growing on lichen species of the genera *Aspicilia*, *Lobothallia* and *Megaspora* (*Megasporaceae*) is presented. The following species are proposed as new to science: *Cercidospora galligena* on *Aspicilia caesiocinerea*; *C. solearispora* on *Aspicilia intermutans*, *A. cinerea*, *A. cupreoglauca*, and sterile *Aspicilia* sp.; and *C. werneri* on *Aspicilia calcarea*, *A. contorta*, and *A. desertorum*. A neotype is chosen for *Microthelia verrucosaria*. A key to *Cercidospora* species on megasporacean hosts is provided.

Key words — *Ascomycota*, lichenicolous fungi, lichenized fungi

Introduction

This study is the first contribution to an ongoing revision of the genus *Cercidospora* (*Dothideales*, incertae sedis). It focuses on species growing on lichens of the genera *Aspicilia*, *Lobothallia* and *Megaspora* (*Megasporaceae*, *Pertusariales*; Lumbsch et al. 2004, Lumbsch & Huhndorf 2007). The taxa of these three genera were traditionally included in a wider concept of the genus *Aspicilia* (cf. Ozenda & Clauzade 1970, Clauzade & Roux 1995, Wirth 1980). The only *Cercidospora* species previously known to occur on these genera were *C. verrucosaria*, a parasite of *Megaspora verrucosa* (cf. Arnold 1890, Clauzade et al. 1989, Grube & Hafellner 1990), and the recently described *C. lobothalliae* on *Lobothallia radiosa* (Navarro-Rosinés et al. 2004).

The concept of the genus *Cercidospora* is clearly established in Hafellner (1987) and Grube & Hafellner (1990). Hafellner (1987) redefined the genus and separated the species based mainly on variations in ascospore shape and size as well as by different hosts. In Grube & Hafellner (1990), the genus *Cercidospora* is delimited and compared with other mainly hyalodidymo-spored genera, viz. *Didymellopsis* and *Zwackhiomyces*, that included taxa previously included in a wide concept of *Didymella* (Vouaux 1913, Keissler 1930, Clauzade & Roux 1976). Initially, this genus comprised fungi with perithecioid ascomata and characterized by colorless, 1-septate ascospores and clearly persistent interascal filaments (paraphysoids) in the hamathecium. Later, the generic concept was enlarged to include some taxa with pluriseptate ascospores previously referred to *Metasphaeria* (Hafellner 1987) and species with simple ascospores (Navarro-Rosinés et al. 2004).

Separation of the taxa included in *Cercidospora* has been considered variously by different authors. Some authors have recognized only wide species concepts without taking into account the variations in shape and size of the ascomatal structures (Keissler 1930, Santesson 1960) or treated such variations at the infra-specific level (Vouaux 1913). At the present time, however, the revisional works on lichenicolous fungi tend to consider these variations in size and shape of ascomatal structures and their parts as stable characters of speciation that relate to the specificity of these fungi with their respective host lichens (cf. Hafellner 1987, Grube & Hafellner 1990).

Material and methods

For the microscopic study of the morphology and anatomy of the species, sections of ascomata were prepared by hand, and mounted in water or, to increase the contrast, in lactophenol-cotton blue. All measurements of the different structures were made in water. For the illustrations, a drawing tube fitted to the microscope was used. In the size of the ascospores, the values in italics indicate the average value of length and width, the values in brackets are the extreme values, and the remaining values are the extreme values after rejecting 10% of the highest and 10% of the lowest values. The nomenclature of the host species follows Clauzade & Roux (1985, 1987, 1989), Hafellner & Türk (2001) and Nimis (1993), except for some commented exceptions.

General features of the genus *Cercidospora*

Cercidospora Körb. emend. Hafellner

Parerga Lichenologica: 465 (1865) and Herzogia 7: 354 (1987).

TYPE SPECIES: *Cercidospora ulothii* Körb. [syn. *Cercidospora macrospora* (Uloth) Hafellner & Nav.-Ros.].

The genus *Cercidospora* comprises only lichenicolous fungi with ascomata immersed in the host thallus or apothecia. Exceptionally, deformations in form of cecidia in which ascomata are grouped can be observed.

The ascomata are perithecioid (pseudothecia), externally blackish, smooth, ostiolated, variable in size in the different species, and more or less immersed in the host thallus. The peridial wall is usually intensely pigmented near the ostiolum, this pigment being amorphous and variable in color, from blue-green to violet-brown or blackish; in contrast, the basal part of the ascomata is generally colorless, although in some taxa, it may be more or less pigmented. The wall is formed by thin hyphae, with much reduced cells that do not form a clearly prosoplectenchymatic structure, rather recalling the so-called *textura intricata* (Hawksworth et al. 1983). Between the fungal ascomata and host thallus, a colorless layer formed by cells with a reduced lumen can frequently be observed.

The hamathecium is formed by paraphysoids, the abundance of which is variable in the different taxa. They are filiform, septate, simple or with some anastomoses.

The asci are typically fissitunicate, cylindrical, or cylindrical-clavate, with the endoascus apically slightly thickened and provided with a small ocular chamber. They contain a variable amount of ascospores depending on the different taxa, ranging from 2 to 8 per ascus.

The ascospores are colorless, with one or more transversal septa in most species and simple only in *C. lobothalliae*; their form is oval, ellipsoid or fusiform, heteropolar or not, strongly heteropolar in some taxa. The occurrence of a perispore in the form of a thin gelatinous sheath is characteristic; this character is especially visible in young ascospores.

Diagnostic for the genus are the pigmentation and texture of the peridium, the persistent paraphysoids, the fissitunicate cylindrical asci, and the hyaline ascospores with a thin perispore. Infrageneric variables important for distinguishing species are mainly the color of the peridial pigment, the number of ascospores per ascus, the ascospore shape and number of septa, quantitative characters of all parts of the ascomata and host selection.

The species

***Cercidospora galligena* Hafellner & Nav.-Ros., sp. nov.**

FIG. 1

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Ascomata perithecioidea, in areolis convexis aut in gallis supra thallum hospitis evolutis immersa. In sectione transversali pseudothecia globosa, (100–)120–190 µm in diametro. Paries ascomatum apicaliter brunnescens vel viridulo-nigrescens, parce incrassatus, basaliter subhyalinus, 10–20 µm crassus. Paraphysoides copiosae, parce ramoso-anastomosantes, 1.5–2 µm in diametro. Asci cylindrico-clavati, 50–75 µm longi et 12–15 µm lati, 6–8-spori. Ascosporae (13.5–)14–19 × 5–6(–7) µm magnae, incoloratae, 1-septatae, ellipsoidales, rectae vel leviter curvatae, utroque apice rotundatae, septo mediano, at septum non aut parum constrictae, cum cellulis superioribus haud multum crassioribus quam cellulae inferiores.

Cercidosporae verrucosariae affinis, sed eae dissimilis praesertim ascis brevioribus et latioribus, et ascosporis ellipsoidalibus cum apicibus late rotundatis. Supra thallos Aspiciliae caesiocinereae et specierum aliarum vigens.

TYPUS: Spain, Catalonia, prov. Girona: Nuria N von Ribes de Freser, NE von der Bergstation der Zahnradbahn, ca. 2100–2200 m, Südhänge mit subalpinen Rasen und Kalkschieferschrofer, 27.V.1990, J. Hafellner 17371 (GZU- holotypus).

HOST SPECIES OF THE TYPE: *Aspicilia caesiocinerea* (Nyl. ex Malbr.) Arnold.

ETYMOLOGY: From *galligena* (Lat.), inducing the formation of cecidia (galls).

DESCRIPTION — Fungus cecidiogenous, producing convex areoles or small cecidia on the host thallus. Ascomata grouped in cecidia, perithecioid, (100–)120–190 µm diam.; exciple from dark brown to violet-black in the upper part and around the ostiole, colorless in its lower half, and there 10–20 µm thick. Paraphysoids abundant, 1.5–2 µm wide. Asci 50–75 × 12–15 µm, cylindrical-clavate, (4–)6–8-spored. Ascospores (13.5–)14–16.3–19 × 5–5.7–6(–7) µm, with a length/breadth ratio of (2.0–)2.5–2.8–3.2(–3.5) ($n = 45$), 1-septate, but sometimes some simple ascospores also present, oval-ellipsoid or ellipsoid, slightly heteropolar, with the lower cell only slightly attenuated toward its apex, both apices rounded, septum centered, not or slightly curved.

REMARKS — *Cercidospora galligena* shows ascospore sizes similar to those of *C. verrucosaria*, a fungus occurring on *Megaspora verrucosa*. Besides the different host species, these two taxa differ in ascus size, ascospore shape, and in either the production or the lack of cecidia on the host thallus. The asci of *C. verrucosaria* are typically cylindrical, with 65–95(–105) × (8–)9–11 µm, longer and narrower than those of *C. galligena*. The ascospores of *C. verrucosaria* are ellipsoid-fusiform, not oval-ellipsoid as in *C. galligena*. With regard to the cecidiogenous capacity of these species, *C. verrucosaria*, contrary to *C. galligena*, does not induce the formation of cecidia on the host thallus.

DISTRIBUTION AND HABITAT — *Cercidospora galligena* is currently known only from a few scattered localities in some European countries, namely Spain (Catalonian Pyrénées and Sierra Nevada), Austria, and Sweden, from where it was already reported prior to its valid publication (Santesson 1993). Furthermore we saw a specimen from Greenland. It has been collected on thalli of *Aspicilia caesiocinerea*, *A. grisea*, *A. simoensis*, and unnamed *Aspicilia* species.

ADDITIONAL SPECIMENS EXAMINED—Europe: Austria: Kärnten, Nationalpark Hohe Tauern, Schober-Gruppe, Klammer Scharte zwischen dem hintersten Gössnitzbal und dem hintersten Gradental, 2930 m, GF 9042/2, Gneisfelsen, 9.VII.1988, J. Hafellner & M. Walter (GZU, herb. J. Hafellner 21841). On *Aspicilia grisea*. – Salzburg, Nationalpark Hohe Tauern, Glockner Gruppe, NW-Grat des Grossen Magrötzen Kopfs W ober dem Hochtor, knapp NE unter dem Grat, [47°05'10"N / 12°50'10"E], c. 2620 m, GF 8943/1, Granatglimmerschiefer, auf NE-exponierten Schrofen und Blöcken, 5.VIII.1996, J. Hafellner & H. Wittmann (herb. Hafellner 38187). On *Aspicilia simoensis*. – Tirol,

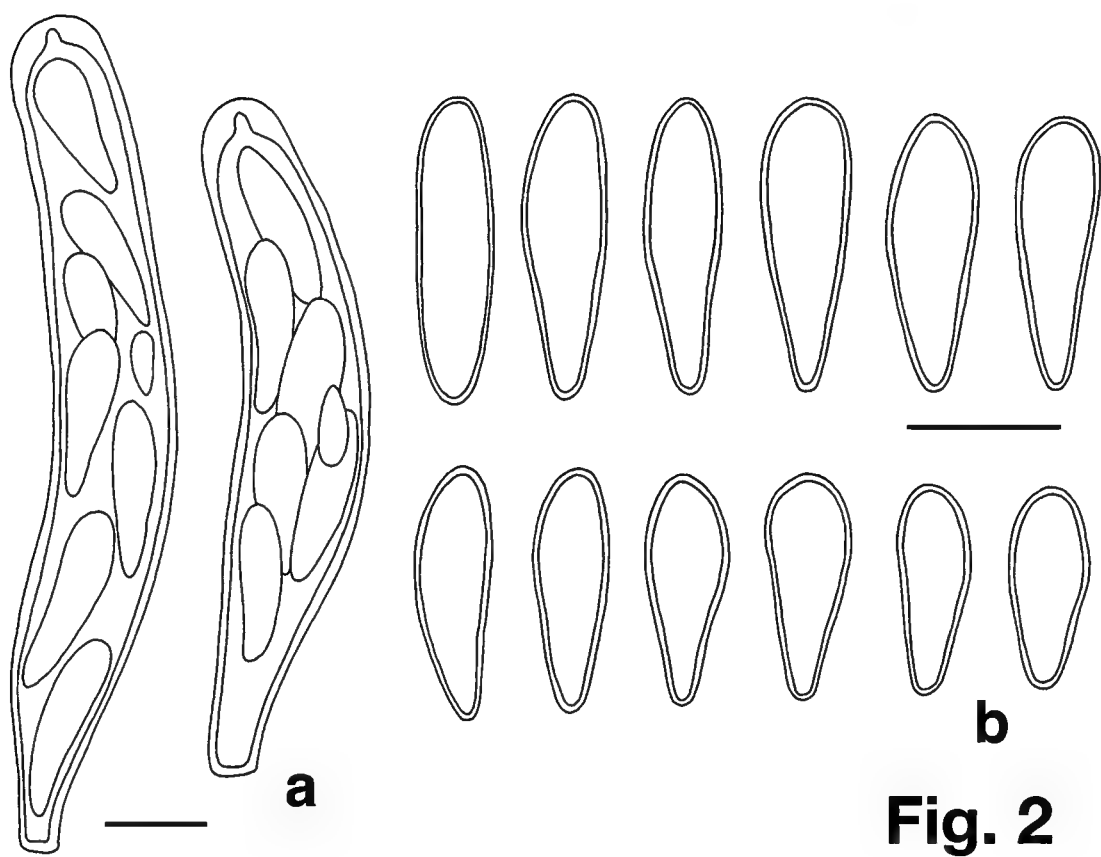
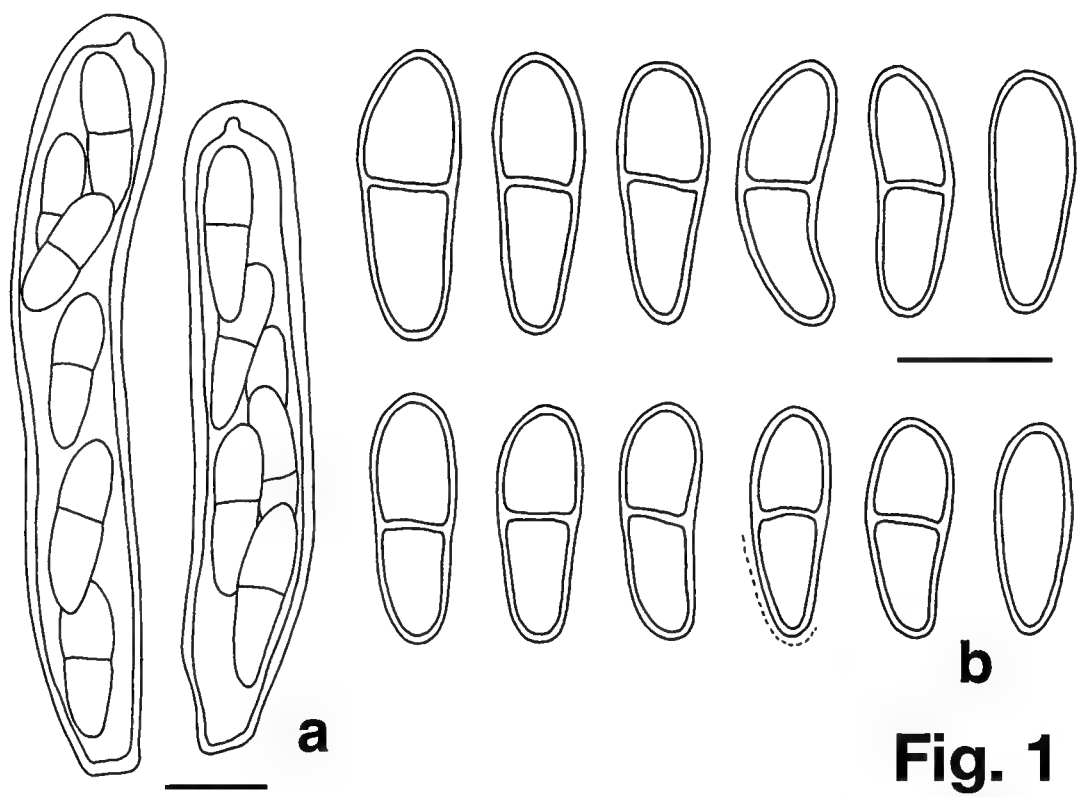


FIG. 1. *Cercidospora galligena* (holotype). a, asci; b, ascospores.
FIG. 2. *Cercidospora lobothealliae* (holotype). a, asci; b, ascospores.
All scales: 10 μ m.

Rhätische Alpen, Samnaun-Gruppe, S-seitige Abbrüche der Hänge SE unterhalb Serfaus, 1100–1400 m, Kalkschiefer, sehr trocken, IX.1972, J. Poelt (GZU). On *Aspicilia* sp. – **Spain**: Andalucía, prov. Granada, sur schistes dans la Sierra Nevada, au lieu-dit Valle del Infierno, 2600 m, 7.VI.1934, R.G. Werner (BC, Herb. Werner). On *Aspicilia caesiocinerea* [mentioned as *A. recedens* in Werner 1937]. – **Sweden**: Göteborg, Lilla Änggården, 4.X.1957, A. H. Magnusson 25144 (UPS, GZU). On *Aspicilia* sp. – Bohuslän, Lysekil commune, Skaftö par., Islandsberg, c. 1 km S of Grundsund, on trail to Islandsbergs Huvud, c. 50 m alt., open heathland with gneiss outcrops, on exposed rock faces, 29.VIII.1992, J. Hafellner 30510 (herb. Hafellner). On *Aspicilia* sp. – **North America: Greenland**: W-Grönland, Disko, Umgebung von Godhavn, Unteres Bläsedal NE Godhavn, 50–100 m, 29.VII.1982, J. Poelt & H. Ullrich (GZU). On *Aspicilia* sp.

Cercidospora lobothalliae Nav.-Ros. & Calat., Lichen Flora of the Greater Sonoran Desert Region 2: 637 (2004).

FIG. 2

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TYPUS: Spain: Catalonia, prov. Tarragona, Baix Ebre, Roquetes, Barranc de la Caramella, U.T.M. 31TBF7920-7919, 400–500 m, 19.X.1986, M. Boqueras & P. Navarro-Rosinés (BCC-Lich. holotypus).

HOST SPECIES OF THE TYPE: *Lobothallia radiosa* (Hoffm.) Hafellner.

DESCRIPTION — Ascomata perithecioid, 120–160(–200) μm diam.; exciple in the upper part blue-green, basally colorless, c. 10 μm thick. Paraphysoids relatively abundant, 1.5–2(–2.5) μm wide. Asci (50–)60–80 \times (10–)12–13 μm , cylindrical-clavate, with (4–6–)8 ascospores. Ascospores (13–)16–18.5–21.5 (–24) \times (4.5–)5–5.4–6 μm , with a length/breadth ratio of (2.4–)2.9–3.4–4.1(–4.8) ($n = 48$), simple, colorless, ellipsoid to fusiform, heteropolar, with a narrower lower part, with a thin sheath especially visible in the youngest ascospores, guttulate.

REMARKS — *Cercidospora lobothalliae* is characterized among other *Cercidospora* species by its regularly simple ascospores. In other species such as *C. crozalsiana* (Navarro-Rosinés et al. 1995) simple ascospores may also occur, but together with the more abundant 1-septate ones. Another remarkable character of *C. lobothalliae* is the small size of the ascomata, mostly 120–160 μm diam.; they are the smallest of all the species treated here.

DISTRIBUTION AND HABITAT — *Cercidospora lobothalliae* is known from Mediterranean Europe (eastern Spain and Crete), arctic Asia (Russia), and western North America (California), most of the localities having been mentioned by Navarro-Rosinés et al. (2004), and two recently by Zhurbenko (2009). In all cases, the lichenicolous fungus grows as a specific parasymbiont on *Lobothallia* spp., mainly *L. radiosa*. Zhurbenko (2009) added *L. melanaspis* to the list of host taxa.

EXSICCATA: None.

ADDITIONAL SPECIMENS EXAMINED: See Navarro-Rosinés et al. (2004).

Cercidospora solearispora Calat., Nav.-Ros. & Hafellner, sp. nov.

FIG. 3

MYCOBANK MB 514140

Ascomata perithecioida, immersa in thallis hospitis. In sectione transversali pseudothecia globosa, 160–230 µm in diametro. Paries ascomatum apicaliter viridulo-caerulescens, parce incrassatus, basaliter subhyalinus, 11–18 µm crassus. Paraphysoides copiosae, 1–1.5 µm in diametro. Asci cylindrico-clavati, circa 50–70 µm longi et 10–15 µm lati, (6–)8-spori. Ascosporae (15–)17–21(–22) × (4.5–)5–6(–7) µm magnae, incoloratae, uniseptatae, rariore simplices, fusiformes vel anguste soleiformes, cellulis inaequalibus, cellula inferiore attenuata, distincte brevior angustioreque quam cellula superior, ad septum non aut parum constrictae.

Cercidosporae verrucosariae affinis, sed eae dissimilis ascosporibus soleiformibus. Supra thallum Aspiciliae intermutantis et specierum aliarum vigens.

TYPUS: Spain, Comunidad Valenciana, prov. de Castelló, Alfondeguilla, Pico Nevera, U.T.M. 30SYK3115, 740 m, 10.VI.1989, V. Calatayud (VAB-lich. 1982 holotypus).

HOST SPECIES OF THE TYPE: *Aspicilia intermutans* (Nyl.) Arnold.

ETYMOLOGY: From *solearis*, -e, adj. (Lat.) [from *solea*, -ae, subst., sole, sandal], something which has the shape of a sandal (Blanquez 1946) and *spora*, -ae subst. (Lat.), spore, in this case meaning ascospore; referring to the sole-shape of the ascospores in optical section view.

? SYN.: *Didymella ulothii* var. *apiosporoides* Vouaux, in Bouly de Lesdain, Bull. Soc. Bot. France 56: 175 (1909). Typus: France, Puy-de-Dôme, Puy-Crouel, leg. Brevière (?) [n. v.]. Host: “sur thalle stérile saxicole” (Bouly de Lesdain 1909: 175, Vouaux 1913: 90).

≡ *Didymella epipolytropa* var. *apiosporoides* (Vouaux) Vouaux, Bull. Soc. Mycol. France 29: 90 (1913).

DESCRIPTION — Fungus cecidiogenous only in some cases (on *A. cinerea*), producing small cecidia on the host thallus. Ascomata perithecioid, 160–230 µm diam., globose; lower half of exciple colorless, blue-green around the ostiole, 11–18 µm thick towards the lower part of the ascomata. Paraphysoids abundant, 1.5–2 µm wide. Asci 50–70 × 10–15 µm, cylindrical-clavate, (6–)8-spored. Ascospores (15–)17–18.8–21(–22) × (4.5–)5–5.4–6(–7) µm, with a length/breadth ratio of (2.6–)3.0–3.5–4.2(–4.8) ($n = 93$), 1-septate, or occasionally also simple, between narrowly fusiform and soleiform, with the two cells markedly heteropolar, with a very different shape and size, lower cell much shorter and narrower than the upper one, with only 1/3 to 1/4 of the overall length of the spore.

REMARKS — *Cercidospora solearispora* is easily separated from the rest of species growing on *Aspicilia* s.l. The marked heteropolarity of the ascospores, with the lower cell much shorter and narrower than the upper one, is diagnostic. Ascospores with a similar shape occur in some specimens of *Cercidospora* growing on different *Caloplaca* species, but in them, the lower cell is more acute and somewhat larger than in *C. solearispora*. Such *Cercidospora* specimens on *Caloplaca* will be treated in a forthcoming contribution to the revision of this genus, devoted to the species associated with taxa on the *Teloschistales*.

Didymella ulothii var. *apiosporoides* is possibly a synonym of this taxon. According to Vouaux (Bouly de Lesdain 1909: 175; Vouaux 1913: 90), this variety grows “sur thalle stérile saxicole”, which could well be a sterile *Aspicilia* thallus. The ascospore size given by Vouaux (1913), $16\text{--}20 \times 6\text{--}7 \mu\text{m}$, is very similar to that of *C. solearispora*. However, Vouaux stated that in the ascospores, “leur extrémité inférieure est si nettement allongée en forme de queue, ...”, implying that the lower cell is narrower than the upper one. Unfortunately, the length ratio between both cells — regarded as diagnostic for identification of *C. solearispora* — is not given in the description by Vouaux (1913). There is no specimen of *Didymella ulothii* var. *apiosporoides* among the remnants of the Vouaux herbarium (Rondon 1969), and the herbarium of Bouly de Lesdain was destroyed during World War Two (Grumann 1974). As the application of the name is not entirely clear, it has not been taken up by us.

DISTRIBUTION AND HABITAT — *Cercidospora solearispora* is a relatively abundant species known from different localities in Austria, the Czech Republic (Kocourková 2000, Vondrák et al. 2007), France, Spain, and Turkey (Halıcı et al 2007). It grows on *Aspicilia* species, mostly reacting K⁺ red in the thallus and on strains of the *Aspicilia caesiocinerea* complex. Among the species containing norstictic acid, we could identify *A. cinerea*, *A. cupreoglauca*, and *A. intermutans*. However, in many of the specimens examined, a reliable identification of the host was not possible as the material is sterile or belongs to taxonomically unresolved species complexes within *Aspicilia*. In a number of cases the infection with a lichenicolous fungus may have contributed to inhibit apothecium development of the host lichen, which is an unusual fact in *Cercidospora*. Other hosts mentioned for this species include *Aspicilia contorta* (fide Kocourková 2000), *A. contorta* subsp. *hoffmanniana* (fide Vondrák et al. 2007) and a sterile grey crustose lichen (fide Halıcı et al 2007).

EXSICCATA — none.

ADDITIONAL SPECIMENS STUDIED — **Austria:** Kärnten, Gurktaler Alpen, Nockgebiet, N von Radenthein, Langalmthal, knapp S der Veidlhütte, WNW der Schartenalm, auf Silikatfels in Ufernähe des Rossbaches, 1380 m, GF 9148/1, 23.IX.1988, H. Wittmann (GZU). On *Aspicilia caesiocinerea* coll. — Steiermark, [Seetalerer Alpen], ca. 2 km NW von Neumarkt, beim Gasthof Vetterl, ca. 900 m, GF 8952/1, niedrige phyllitische Felsblöcke auf einer Viehweide, 13.IX.1987, W. Obermayer 1935 (GZU). On *Aspicilia cinerea*. — Steiermark, W-Abhang der Seetaler Alpen, 5 km E von Neumarkt, Oberberg, 200 m unter dem Gehöft Schweintaler, 1250 m, GF 9852/2, offene Waldweide, Felsblöcke, 20.III.1987, W. Obermayer 1934 (GZU). On *Aspicilia* sp. — Oberösterreich, Donautal, Schlögener Schlinge, Steiner Fels, 380 m, GF 7549, auf silikatischen Felsen, 24.XII.1995, F. Berger 9514 (GZU). On *Aspicilia caesiocinerea* coll. — **Czech Republik:** Bohemia centralis, Beroun, regio protecta Křivoklátsko, vicum Stará Ves prope pagum Hudlice, in rupibus diabasicis, alt. 340 m, GF 6049, 10. XI.1996, J. Horáková & P. Kocourek (GZU). On *Aspicilia* sp. — **France:** Lozère, Cévennes, la Roquette, N von le Pompidou, W von Alès, 670 m, S-exponierte Gneisabbrüche, G. Clauzade, C. Roux & J. Hafellner (herb. Hafellner 21951). On *Aspicilia* cf. *cinerea* (sterile). — **Italy:** Sardinien, Prov. Cagliari, Porto

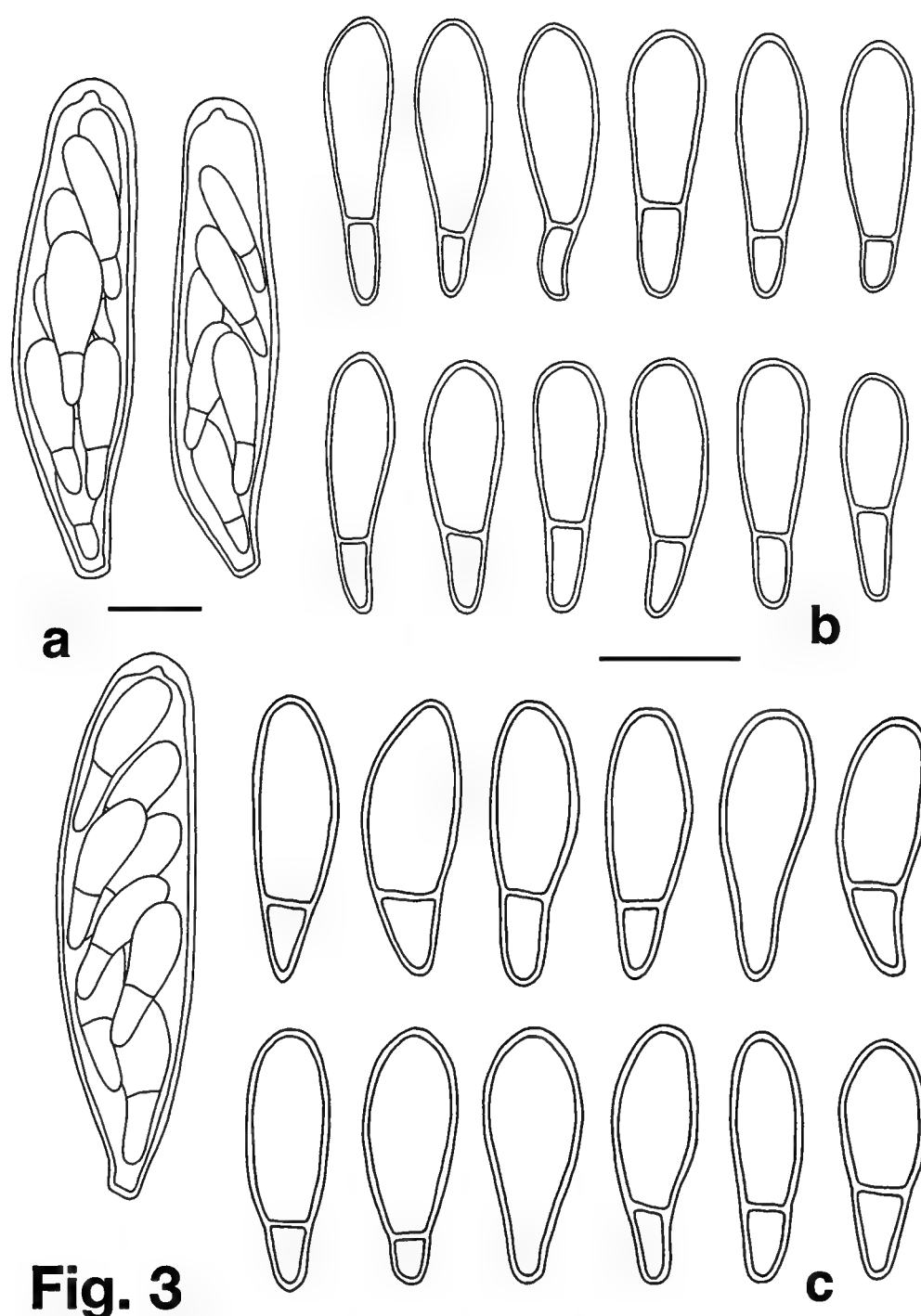
**Fig. 3**

FIG. 3. *Cercidospora solearispora* (a, b, Créixer, Catalonia, Spain; c, holotype).
a, asci; b, c, ascospores. All scales: 10 μ m.

S. Stefano nahe Capo Carbonara, 2–4 m alt., Küstenfelsen, 17.VII.1985, J. Poelt (GZU). On *Aspicilia calcarea* coll. – Sardinien, Prov. Cagliari, Tal des Rio Giutturu Mannu, NW-exponierte Quarzit-Wand nahe der Kreuzung Ciri Fiddi, um 90 m, 18.VII.1985, P. L. Nimis & J. Poelt (GZU). On *Aspicilia* sp. – Valle d'Aosta, Castello di Chatelard (La Salle), ca. 1100 m alt., 29.X.1973, A. Buschardt (herb. Hafellner 10110). On *Aspicilia* sp. – Slovenia: Central Alps, Kobansko, Koralpe, mountain top ("Jantschkifels") 7,6 km NE above Dravograd (Unterdrauburg) (W above the chapel Sv. Urban), uppermost slopes exposed to S just below the summit close to the border to Austria, 46°39'08"N / 15°03'49"E, ca. 1360 m, scattered boulders of garnet schist on clearings in the spruce forest, on inclined rock faces of the boulders, 20.VII.2008, J. Hafellner no. 72607 (herb. Hafellner). On *Aspicilia cinerea* (th.). – Spain, Catalonia: Prov. Girona, Alt Empordà,

Vilajuïga, Castell de Carmençó, U.T.M. 31TEG0787, 100 m, P. Navarro-Rosinés, X. Llimona & C. Roux, 7.III.1992 (BCC-lich.). On *Aspicilia cupreoglauca*. – Prov. Girona, Baixa Cerdanya, Crèixer, cerca del pueblo U.T.M. 31TDG0396, 1400 m, X. Llimona & J.M. Pérez-Redondo, 30.XI.1990 (BCC-lich.). On *Aspicilia cinerea*. – Prov. Girona, Baixa Cerdanya, Meranges, prado cerca de Guirult, U.T.M. 31TCH9900, 1600 m, X. Llimona & J.M. Pérez-Redondo, 17.IV.1992 (BCC-lich.). On *Aspicilia* sp. (K-, st.). – **Comunidad Valenciana**: prov. de Valencia, Puçol, el Picaio, U.T.M. 30SYJ3091, arenisca, 350 m, 26.II.1992, V. Calatayud (VAB-lich. 7875). On *Aspicilia intermutans*.

***Cercidospora verrucosaria* (Linds.) Arnold, Flora 57: 154 (1874)**

FIG. 4

MYCOBANK MB 212739

BAS.: *Microthelia verrucosaria* Linds., Quart. J. Microsc. Sci. 9: 349 (1869).

≡ *Arthopyrenia verrucosaria* (Linds.) Arnold, Flora 57: 139 (1874).

≡ *Didymella verrucosaria* (Linds.) Sacc. & D. Sacc., Syll. Fung. 17: 657 (1905).

≡ *Didymosphaeria verrucosaria* (Linds.) Magnus, in Dalla Torre & Sarnthein, Flora von Tirol 3: 473 (1905).

TYPUS: Great Britain, Scotland, Craig-na-Galliach and Ben Lawers, leg. Maingay, E- (n. v., see remark below). – Austria: Styria, Eastern Alps, Niedere Tauern, Wölzer Tauern, Rettlkirchspitze NW of the little town Oberwölz, slope exposed to the N c. 1 km W of the refuge Neunkirchner Hütte, 47°16'15"N / 14°08'00"E, c. 1720 m alt., GF 8750/2, marble outcrops in subalpine pasture, on plant remnants, 24. VIII. 2002, J. Hafellner (60688) & J. Miadlikowska = Hafellner, Lichenicolous Biota 33 (GZU, neotypus; BR, CANB, NY, UPS, isoneotypi).

HOST SPECIES OF THE TYPE: *Megaspora verrucosa* (Ach.) Hafellner & V. Wirth.

ILLUSTRATIONS: Vězda (1970: 223, fig 2).

DESCRIPTION — Ascomata perithecioid, 130–200(–300) µm diam., globose; exciple colorless in its lower half part and dark bluish brown around the ostiole, 10–15 µm thick towards the base of the ascomata. Paraphysoids relatively abundant, 1.5–2 µm thick. Asci 65–95(–105) × (8–)9–11 µm, elongate subcylindrical, 8-spored, exceptionally only 4-spored. Ascospores (14.5–)15.5–17.6–19.5(–23) × (4.5–)5–5.4–6(–7) µm, with a length/breadth ratio of (2.1–)2.8–3.3–3.8(–4.4) ($n = 113$), 1-septate, but some simple, ellipsoid or fusiform, slightly heteropolar, not constricted at the septum, halonate.

REMARKS — The fact that the type of *Cercidospora verrucosaria* could not be found in W.L. Lindsay's herbarium, in Edinburgh (Hawksworth 1985, Hawksworth & Diederich 1988), has complicated the understanding of this taxon. Correct delimitation is further complicated in that the original description by Lindsay (1869), later adopted by Vouaux (1913), does not provide dimensions of the ascospores, which are described only as oval-oblong and 8 per ascus. We have selected a neotype in order to stabilize the name.

Fortunately, *Cercidospora verrucosaria* is a relatively abundant taxon and examination of numerous specimens has allowed us to study character variations to compare with other taxa; as a conclusion, it is regarded here as

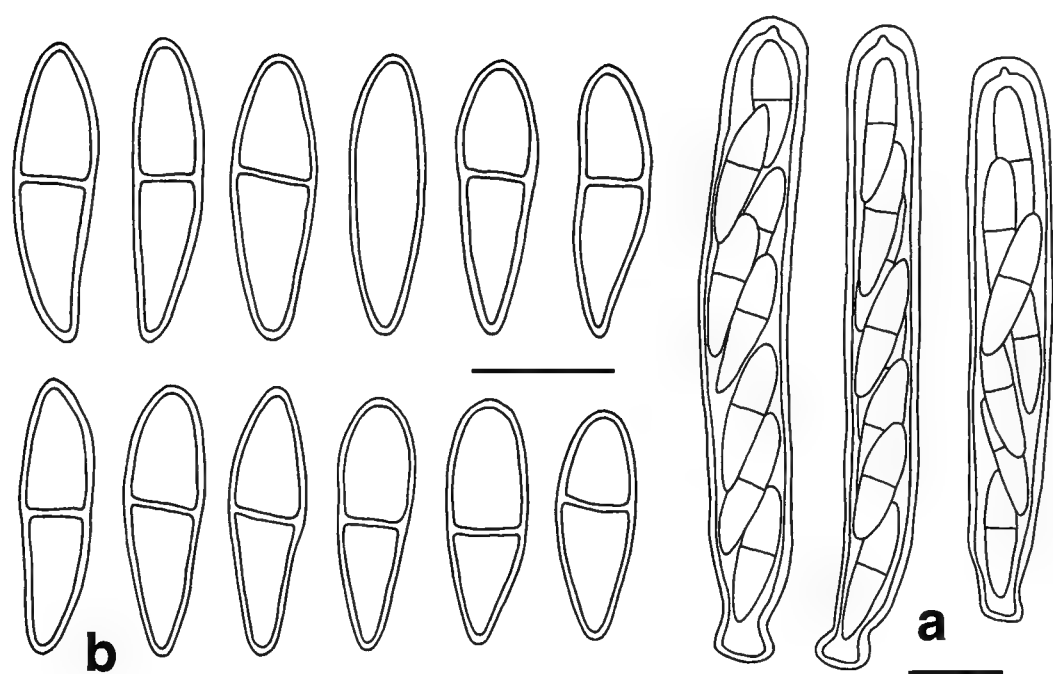


Fig. 4

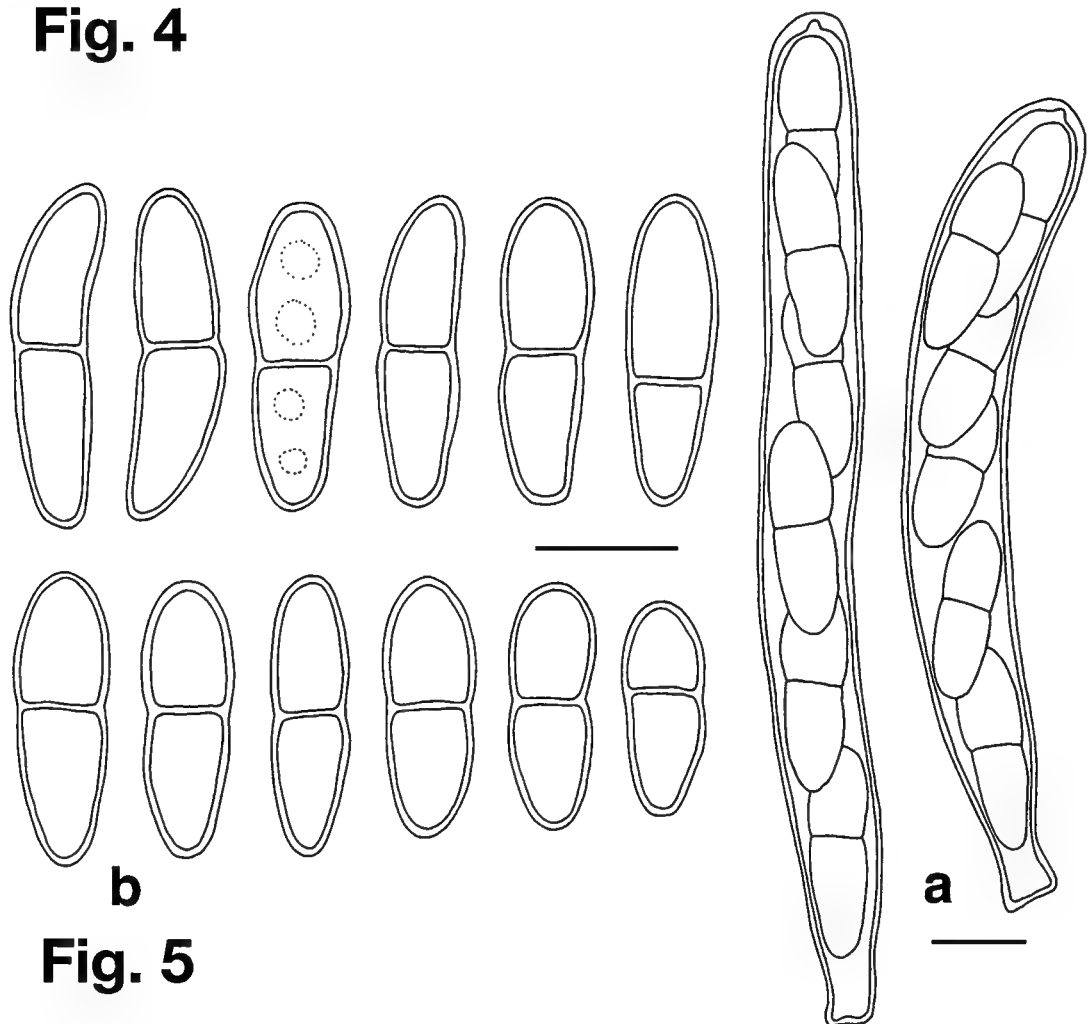


Fig. 5

FIG. 4. *Cercidospora verrucosaria* (Urús, Catalonia, Spain).
a, asci; b, ascospores.

FIG. 5. *Cercidospora mutabilicola* ined. (Puebla de San Miguel, Comunitat Valenciana).
a, asci; b, ascospores.
All scales: 10 µm.

a specific parasite of *Megaspora verrucosa*. *C. verrucosaria* is characterized by \pm constantly 8-spored asci and 15–19 μm long ascospores. Our observations agree with data cited by Arnold (1890) but differ slightly from the description of *C. "epipolytropa"* by Vězda (1970), based on specimens growing on *Megaspora verrucosa*. Vězda described *C. "epipolytropa"* as having asci with 4, 6 or 8 spores and ascospores that are much larger ($13\text{--}30 \times 4\text{--}8 \mu\text{m}$) in both length and width than in our measurements. On the contrary, the spore size reported by Vězda is not reflected in his own illustrations (Vězda 1970: 223, fig 2) that depict all ascospores with a similar size and shape. We suspect that the author included immature ascospores in his measurements.

The above description is based on European samples including the neotype specimen, all growing on muscicolous or terricolous specimens of *Megaspora verrucosa*, on which ascomata can develop on the thallus, along apothecial margins, and even in the hymenia. Sonoran specimens referred to *C. verrucosaria* s.l. grow on the corticolous variety, *Megaspora verrucosa* var. *mutabilis*, and have 4-spored asci (Navarro-Rosinés et al. 2004). European specimens on the same corticolous variety might represent a different entity, mentioned in the literature as *C. mutabilicola* Calat. et al., nom. nud. (Navarro-Rosinés et al. 2004). In this taxon, ascomata and ascospores are larger than in typical specimens growing on *M. verrucosa* var. *verrucosa* (FIG. 5). A short description based on this material (listed at the end) follows: Ascomata perithecioid, 230–350 μm diam., globose; exciple colourless at the base, and violet-brown in the upper half, close to the ostiole, c. 10 μm thick in the lower part of the ascomata. Paraphysoids abundant, (1.5–)2(–2.5) μm wide. Asci 70–110 \times 9–13 μm , cylindrical, (4–)6(–8)-spored. Ascospores (15.5–)18–21.0–24(–25) \times 5–6–7 μm , with a length/width ratio of (2.4–)2.9–3.6–4.2(–5.8) ($n = 63$), 1-septate, ellipsoid, at both ends rounded, not or only slightly heteropolar, not or slightly constricted at the septum, without an apparent sheath. Further studies involving the study of more material of specimens on *M. verrucosa* var. *mutabilis* from different geographic areas are still needed in order to clarify if these specimens merit being considered as a formally separate taxon from *C. verrucosaria* s. str., and to better define the limits between possible different entities.

The morphological characters of *Cercidospora verrucosaria* are close to those of *C. galligena*. For its separation, see the comments given in its description.

DISTRIBUTION AND HABITAT — *Cercidospora verrucosaria* has been reported from its original locality in Scotland, and from different sites in Europe including Austria (Bilovitz & Mayrhofer 2008, Hafellner 2000, 2002, 2008a, 2008b, Hafellner & Obermayer 2007, Hafellner & Türk 1995, Hafellner & Wittmann 1996, Hafellner et al. 2004, 2005a, 2005b, 2008, Obermayer 1999), Germany (Arnold 1890, Triebel & Scholz 2001), Great Britain (Lindsay 1869), Iceland (Svane & Alstrup 2004), Italy (Arnold 1896, Kernstock 1893),

Norway (Santesson 1993), Russia (Zhurbenko 2002, 2004, 2008, 2009), Sweden (Santesson 1993), Switzerland (Boissière et al. 1989). Outside Europe it is known from the Canary Islands (La Palma, Berger & Etayo 1998), North America (Arizona and Chihuahua, Navarro-Rosinés et al. 2004), and New Zealand (Hafellner & Mayrhofer 2007). Other citations of this species have been included in a wide concept of *C. epipolytropa* (cf. Vězda 1970, from Slovakia). It grows as a parasymbiont on *Megaspora verrucosa*, a muscicolous or terricolous lichen, dwelling mainly in alpine and subalpine vegetation belts of high mountain ranges.

EXSICCATA—Hafellner, Lichenicolous Biota 33 (BR, CANB, GZU, NY, UPS); Obermayer, Dupla Graecensia Lichenum 46 (BC, CANB, GZU, M, NY, UPS).

SELECTED SPECIMENS EXAMINED (including only a geographically representative selection cited; all specimens growing in thalli and apothecia of *Megaspora verrucosa*)—**Europe:** **Austria:** Niederösterreich, Nördliche Kalkalpen, Schneeberg NW von Neunkirchen, Kaiserstein, knapp E unter dem Gipfel am Südrand der Abbrüche in die Breite Ries, 47°46'25"N / 15°48'45"E, ca. 2000 m, GF 8260/2, Rasentreppen mit kleinen Kalkschrofen auf Moosen und Pflanzenresten, 29.VI.1997, J. Hafellner 42244 (GZU). – Steiermark, Dachstein-Gruppe, Gipfel des Stoderzinkens [N von Gröbming], windgefegte Rasen auf der Nordseite, ca. 2050 m alt., 29.VII.1976, J. Hafellner 1849 (GZU). – Steiermark, Nördliche Kalkalpen, Totes Gebirge, Tauplitzalm-Gebiet NE von Bad Mitterndorf, Bartlrücken N ober dem Steirersee, 47°37'25"N / 14°01'55"E, ca. 2130 m, GF 8350/3, Windkanten im Gipfelbereich, Caricetum firmæ, auf Pflanzenresten, 4.VII.1999, J. Hafellner 48906 (GZU). – Steiermark, Nördliche Kalkalpen, Ennstaler Alpen, Haller Mauern N von Admont, Hexenturm, im Gipfelbereich, 47°38'47"N / 14°28'55"E, ca. 2170 m, GF 8352/4, Kalkschrofen mit lückiger alpiner Vegetation, S-exponiert auf Moosen und Pflanzenresten, 9.IX.2006, J. Hafellner 67213 (GZU). – Steiermark, Nördliche Kalkalpen, Ennstaler Alpen, Gesäuseberge, Hochzinödl ca. 6,5 km SW von Hieflau, NE über der Hess-Hütte, etwas SW unterhalb vom Gipfel, 47°33'58"N / 14°40'01"E, ca. 2185 m, GF 8454/1, mit Rasenbändern durchsetzte Felsausbisse aus Triaskalk, in erdgefüllten Felsspalten, 20.V.2007, J. Hafellner 68610, L. Muggia & A. Hafellner (GZU). – Steiermark, Eisenerzer Alpen, Zeiritzkampel N von Kalwang, im Gratbereich kurz E vom Gipfel, 47°29'30"N / 14°43'45"E, ca. 2100 m, GF 8554/1, alpine Matten über paläozoischem Kalk, N-seitig auf Moosen und Pflanzenresten, 29.VIII.1997, J. Hafellner 43161 & A. Hafellner (GZU). – Steiermark, Nördliche Kalkalpen, Hochschwab-Gruppe, Brandstein ca. 9,5 km NE von Eisenerz, kurz N unter dem Gipfel, 47°36'05"N / 14°59'00"E, ca. 1990 m, GF 8355/4, Kalkschrofen am oberen Rand der E-exponierten Abbrüche, auf Moosen und Pflanzenresten, 5.VIII.2004, Hafellner 63386 (GZU). – Steiermark, Nördliche Kalkalpen, Mürzsteger Alpen, Veitsch Alpe, Grosser Wildkamm, am SE-Grat ober der Gingatzwiese, 47°39'40"N / 15°24'30"E, ca. 1850 m, GF 8358/1, Kalkschrofen mit Caricetum firmæ-Fragmenten, auf Moosen und Pflanzenresten, 17.V.1997, J. Miadlikowska & J. Hafellner 42632 (GZU). – Steiermark, Niedere Tauern, Schladminger Tauern, Znachsattel S ober der Giglachseehütte S von Schladming, NE-Hänge unmittelbar W ober dem Sattel, 47°16'30"N / 13°38'20"E, ca. 2060 m, GF 8747/2, *Dryas*-reiche Rasen über Kalk, auf Moosen und Pflanzenresten, 27.VIII.2001, J. Hafellner 56649 (GZU). – Steiermark, Niedere Tauern, Wölzer Tauern, Gumpeneck SE von Gröbming, Gipfelpyramide, NW-seitig, 47°23'50"N / 14°00'50"E, ca. 2180 m, GF 8650/1, Marmor, auf Moosen und Pflanzenresten, 10.VI.1993, J. Hafellner 49852 & A. Wilfling (GZU). – Steiermark, Niedere Tauern, Triebener Tauern, Griesmoar Kogel SW von Wald am Schoberpass, im

oberen Teil des E-Rückens, 47°25'05"N / 14°36'20"E, ca. 1920 m, GF 8553/4, S-exponierte Schrofen auf leicht karbonathaltigem Grünschiefer, über Moosen und Pflanzenresten, 14.VII.2001, J. Hafellner 56083 (GZU). – Steiermark, Gurktaler Alpen, N unter der Stang Scharte (zwischen Stang Nock und Gregerl Nock), [46°55'55"N / 13°48'10"E], ca. 2020 m, GF 9048/4, subalpine Zwergstrauchheiden mit einzelnen grossen Felsblöcken, auf Pflanzenresten, 15.VIII.1989, J. Hafellner 6404 (GZU). – Steiermark, Steirisches Randgebirge, Stubalpe, Wölkerkogel oberhalb vom Alten Almhaus, direkt im Gipfelbereich, [47°04'50"N / 14°55'30"E], 1670–1706 m, GF 8955/2, grobkristalliner Marmor, auf Moosen und Pflanzenresten, 13.VIII.1993, A. Wilfling 2300, C. Unger & L. Unger (GZU). – Kärnten, Nationalpark Hohe Tauern, Glockner-Gruppe, Hoher Burgstall NW von Heiligenblut, SE der Oberwalder Hütte, 2960 m, GF 8842/3, alpine Rasenfragmente, 20.IX.1988, J. Hafellner, M. Walther & A. Hafellner 28479 (GZU). – Kärnten, Nationalpark Hohe Tauern, Goldberg-Gruppe, Goldberg-Gruppe, Vorderer Gesselkopf, im untersten Teil des Nordgrates W von der Hagener Hütte, ca. 2500 m, GF 8944/3, Kalkschieferschrofen, E-exponiert auf Moosen und Pflanzenresten, 10.VIII.1994, J. Hafellner 33098 (GZU). – Kärnten, [Steirisches Randgebirge], Koralpe, Grosses Kar N vom Grossen Speikkogel, ober dem markierten Weg zum Schäferkreuz, [46°47'40"N / 14°58'40"E], ca. 1950 m, GF 9255/2, W-exponierte Abbrüche von Marmorschrofen, auf Moosen, 19.IX.1993, A. Wilfling 1744, 1832 (GZU). – Kärnten, Karawanken, Hochobir-Massiv NE von Eisenkappel, am Südgrat knapp unter dem Gipfel, 46°30'15"N / 14°29'15"E, ca. 2100 m, GF 9452/4, niedere Kalkschrofen am Rand der westseitigen Abbrüche, auf Pflanzenresten, 16.VII.1998, J. Hafellner 45667 (GZU). – Salzburg, Hohe Tauern, Glockner-Gruppe, Bergkamm NW vom Kitzsteinhorn, ca. 2 km W ober der Krefelder Hütte, S-Grat der Hinteren Rettenwand, [47°12'40"N / 12°40'45"E], ca. 2680 m, GF 8742/3, Kalkschiefer, auf Moosen und Pflanzenresten, 20.VII.1996, J. Hafellner 38207 & H. Wittmann (GZU). – Salzburg, Nationalpark Hohe Tauern, Goldberggruppe, Vorderer Gesselkopf (Geisslkopf), am Westgrat knapp unter dem Gipfel, [47°00'50"N / 13°04'20"E], ca. 2950 m, GF 8944/3, kalkhaltige Glimmerschieferblöcke auf einem steilen Westhang, auf Moosen und Pflanzenresten, 10.VIII.1994, J. Hafellner 33247 (GZU). – Salzburg, Nationalpark Hohe Tauern, Ankogel Gruppe, knapp N unter dem Westgrat des Greilkopf E ober der Hagener Hütte, [47°01'40"N / 13°05'40"E], ca. 2440 m, GF 8944/4, alpine Matten über Kalkschiefer, auf Pflanzenresten, 27.VIII.1994, J. Hafellner 33044 (GZU). – Salzburg, Radstädter Tauern, Salzburg, Lungau, Umgebung von Mauterndorf, Trogaln zwischen Speiereck und Grosseck, südseitige Abbrüche, Mergelkalk mit Kieselkalklinsen, 2000–2100 m alt., 7.IX.1981, J. Hafellner 9344 (GZU). – Tirol, Osttirol, Nationalpark Hohe Tauern, Glockner-Gruppe, Teischnitztal N von Kals, untere NW-Hänge des Fiegerhorns, SW ober der Teischnitzeben, 47°02'N / 12°39'40"E, ca. 2200 m, GF 8941/4, alpine Matten, auf Moosen und Pflanzenresten über Kalkschiefer, 16.VII.1997, J. Hafellner 46926 (GZU). – **France**: Alta Savoia, Vallorcine, Parc Vieux, a 1,5 km W del Col de Balme, 2100 m, roca calcària, a 0,8 m de sòl, orient SW, incl. 10°, 30.VIII.1988, P. Navarro-Rosinés (BCC-lich. 13279). – **Germany**: Bayern, Allgäuer Alpen, Aggenstein, Aufstieg über den "Schrägen Strich" auf der N-Seite, 1880 m, auf abgestorbener *Carex firma*, 17.X.1951, A. Schröppel & H. Doppelbaur (GZU). – **Italy**: Trentino-Alto Adige, prov. Bolzano (Südtirol), Southern Alps, Dolomiti, M. Seceda (Geisler Spitzen) NE of Ortisei (St. Ulrich), on the ridge just W above Forc Pana (Pana Scharte), 46°36'05"N / 11°44'05"E, ca. 2500 m, low outcrops of limestone in alpine vegetation, on bryophytes and plant debris, 2.IX.2002, J. Hafellner 61216 (GZU). – [prov. Trento], Südtiroler Dolomiten, Marmolada, N-Hänge ober Pian Trevisan, W ober dem Fedaia-Pass, 2240 m, über Moosen und Pflanzenresten, 13.IV.1981, J. Hafellner 9083 (GZU). – **Slovenia**: Julische Alpen, Mangart E vom Predilpass, Steig von der Lahnscharte zum Gipfel des Mangart, ca. 2100 m, auf Pflanzenresten, 21.VII.1979, M. Mayrhofer & H. Mayrhofer

(GZU). – Mangart in den Julischen Alpen, 1873, J. Glowacki (GZU). – **Spain:** Catalonia, prov. Girona, la Cerdanya, Urús, les Suquetes (Moixeró), UTM 31TDG0685, 2140 m alt. sobre *Saxifraga oppositifolia* subsp. *marithiana*, 11.VII.1985, N.L. Hladun (BCC-lich.). – **Switzerland:** Kanton Graubünden, Albula Alpen, Albulapass, W-exponierte Hänge des Piz Uertsch W der Passhöhe, 2400 m, Kalk, auf Pflanzenresten, 26.VIII.1979, H. Mayrhofer 16313 (GZU). – **Asia:** **Nepal:** Central Himalaya, Langtang, above Karka Sarwa, upper alpine belt, 5080 m s. m., scree exposed to the S, on dead mosses covering boulders, 22.IX.1986, G. Miehe no. 12688a & S. Miehe (GZU). – **Australasia:** **New Zealand:** South Island, Canterbury: Mt. Peel, summit, 43°51'S / 171°09'30"E, 1700–1744 m s. m., 16.I.1985, H. Mayrhofer no. 16240, H. Hertel, C.D. Meurk & B.P.J. Molloy (GZU).

SPECIMENS OF *CERCIDOSPORA MUTABILICOLA* INED. EXAMINED (all specimens growing on thalli of *Megasporea verrucosa* var. *mutabilis*): **Europe:** **Italy:** Basilicata, prov. Potenza, N-Abhänge des Monte Pollino, Piana dell Pollino NW Serra delle Ciavole, ca. 1900 m, Weiden und Felskuppen, dazwischen einzelne alte *Pinus leucodermis*, an der Stammbasis von *Pinus leucodermis*, 2.VI.1979, H. Mayrhofer (GZU). – **Spain:** Comunitat Valenciana, prov. València, Puebla de San Miguel, La Canaleja, U.T.M. 30SXK6037, sobre *Juniperus thurifera*, 1440 m, 1.VII.1993, V. Calatayud, V. Atienza & S. Fos (VAB-lich. 7295). – **Switzerland:** In m. Stockhorn (GZU, Schaer, Lich. Helv. exs. 134). – **Asia:** **Cyprus:** Distr. Limassol, Troodos, Gipfel des Mt. Olympus, 1930–1951 m, Felsblöcke, lockere *Pinus nigra* subsp. *pallasiana* und *Juniperus foetidissima* Bestände, auf Borke von *Juniperus foetidissima*, 15.IV.1987, M. Mayrhofer & H. Mayrhofer 16312 (GZU)

***Cercidospora weneri* Nav.-Ros., Calat. & Hafellner, sp. nov.**

FIG. 6

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Ascomata perithecioida, immersa in apotheciis hospitis. In sectione transversali pseudothecia globosa, 150–260 µm in diametro. Paries ascomatum apicaliter viridulo-caerulescens, parce incrassatus, basaliter subhyalinus, 10–25 µm crassus. Paraphysoides ± copiosae, simplices vel leviter ramoso-anastomosantes, 1–1.5 µm in diametro. Asci cylindrici, circa 70–100 µm longi et 8–11 µm lati, plerumque tetraspori. Ascospores (18–) 22–31(–34.5) × (4.5–)5–6(–7) µm magnae, incoloratae, fusiformes, 1(–3)-septatae, cellulis aequalibus aut aliquot inaequalibus, cum cellula inferiore apicaliter attenuata, longioreque quam cellula superior, ad septum non aut parum constrictae, tenuiter halonatae.

Cercidosporae macrospora affinis, sed eae dissimilis ascosporibus cellula inferiore apicaliter attenuata. Supra apothecia Aspiciliae desertorum et supra thallos specierum aliarum vigens.

TYPUS: The Lebanon: sur rochers calcaires au-dessus de Becharré, dans la cédraie et au delà, 2000 m alt., 27.08.1938, leg. R.-G. WERNER (BC - Herb. Werner, holotypus) [holotype of *Lecanora (Aspicilia) auricularis* Werner (WERNER 1956: 467)].

HOST SPECIES OF THE TYPE: *Aspicilia desertorum* (Kremp.) Mereschk.

ETYMOLOGY: *weneri* (Lat.), belonging to Werner; named after Roger-Guy Werner (1901–1977).

DESCRIPTION — Ascomata perithecioid, 150–260 µm diam.; exciple dark blue-green to slightly brown in the upper half, close to the ostiole, and colorless towards the base, (10–)15–25 µm thick in this part of the ascomata. Paraphysoids relatively abundant, 1–1.5 µm wide. Asci 70–100 × 8–11 µm, cylindrical, (2–)4(–8)-spored. Ascospores (18–)22–26.1–31(–34.5) × (4.5–)5–5.4–6(–7) µm,

with a length/breadth ratio of (3.3–)4.0–4.9–5.9(–6.9) ($n = 111$), 1(–3)-septate, colorless, fusiform, not or \pm markedly heteropolar, with the lower cell somewhat attenuate with regard to the upper one, frequently slightly curved, not or only slightly constricted at the septum, guttulate.

REMARKS — Among the species treated here, *Cercidospora weneri* has the largest spore size. The ascospores are usually 1-septate, but 3-septate spores may also be observed. In shape and size of ascospores, asci, and ascomata, *C. weneri* recalls *C. crozalsiana*, a lichenicolous fungus reported on different *Squamarina* species (Navarro-Rosinés et al. 1995). In *C. crozalsiana*, contrary to *C. weneri*, triseptate ascospores have never been observed, although simple ascospores may occur with the predominant 1-septate ones.

In the Spanish specimen of *C. weneri*, the ascospores differ slightly from those of the type. The lower cell, narrower and longer than the upper one, is elongated in the form of a tail and recalls *C. caudata* and *C. epicarphinea*, two fungi of different *Caloplaca* species. However, the two mentioned species have 8-spored asci, contrasting with the primarily 4-spored asci found in *C. weneri*.

Werner (1956) cited this new species as *Didymella epipolytropa* var. *ulothii*. However, *C. macrospora* (syn. *C. ulothii*), a fungus associated with species of *Protoparmeliopsis* (i.e. the *Lecanora muralis* group), has somewhat shorter (primarily 20–25 μm long) ascospores and with both cells equal in shape and size, with the septum centered, more rarely slightly heteropolar (Hafellner 1987).

Specimens of *Cercidospora weneri* growing on *A. calcarea* and *A. contorta* are characterized by shorter ascospores than those observed on *A. desertorum*. On the former two hosts, ascospores measure only (18–)20–22.2–24.5(–26) \times (4.5–)5–5.2–5.5(–6) μm , with a length/width ratio of (3.3–)3.5–4.3–5.1(–5.6) ($n = 26$), but they are also heteropolar, with their lower cell equally attenuated, and are triseptate in some cases. In all studied specimens of *C. weneri*, the ascospore size is larger than in the other studied species of *Cercidospora* growing on *Megasporaceae*.

DISTRIBUTION AND HABITAT — *Cercidospora weneri* is known from the type locality in the Lebanon and from Aragón (Spain), growing as a specific parasymbiont of the apothecia, disc and margin, of *Aspicilia desertorum*, from Provence (France), on the thallus of *A. calcarea*, and from Greenland, on the thallus of *A. contorta*. In the type material, *C. weneri* grows in the thick margins of the apothecia of the holotype of *Lecanora* (*Aspicilia*) *auricularis* (Werner 1956), a heterotypic synonym of *A. desertorum* (Esnault 1985). This calcicolous *Aspicilia* is characterized by having a verrucose thallus and large, sessile apothecia, with a thick thalline margin. In the type specimen of *L. auricularis* all the asci of the host lichen examined were immature, and the ascospores

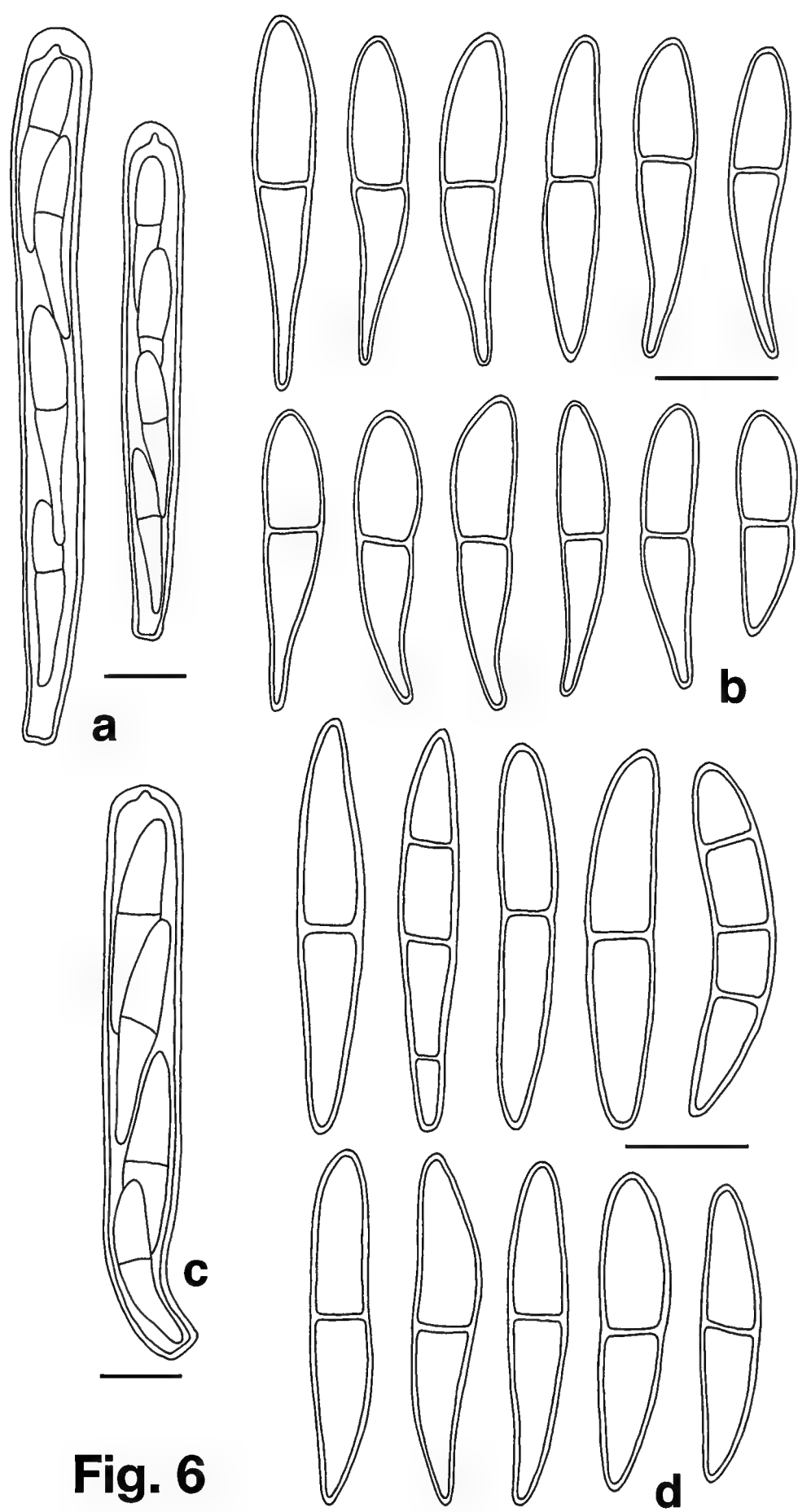


Fig. 6

FIG. 6. *Cercidospora weneri* (a,b, holotype; c, d, Cerro de Javalambre, Aragón, Spain).
a, c, asci; b, d, ascospores. All scales: 10 μ m.

were lacking, as Werner (1956) already mentioned in the original description of this species. This lichen is also a vagrant species dwelling on small calcareous pebbles on basic soil. In Spain, it is restricted to a few continental mountainous areas, being fairly abundant on the top of the Javalambre mountain.

EXSICCATA—none.

ADDITIONAL SPECIMENS EXAMINED—**France:** Dept. Bouches-du-Rhône, Montagne Ste-Victoire, E von Aix-en-Provence, N-Abhänge SW von Vauvenargues, 500 m, Kalk, 16.V.1980, J. Hafellner 8456 (herb. Hafellner). On *A. calcarea*. – **Greenland:** W-Grönland, Disko, Umgebung von Godhavn, SW-Hänge des Skarvefeld, NE über Godhavn, um 500 m, schroffes Gelände, 7.VIII.1982, J. Poelt & H. Ullrich (GZU). On *A. contorta*. – **Spain:** Aragón, prov. Teruel, Camarena de la Sierra, Cerro de Javalambre, U.T.M. 30TXK6841, 2000 m, 4.VIII.1990, V. Calatayud (VAB-lich. 7597). On *A. desertorum*.

Key to the species of *Cercidospora* on species of *Megasporaceae*

- 1a. Ascospores simple; on *Lobothallia* spp. *C. lobothalliae*
[Ascospores $\sim 16\text{--}21.5 \times 5\text{--}6\ \mu\text{m}$; asci $\sim 60\text{--}80 \times 12\text{--}13\ \mu\text{m}$, generally 8-spored; ascomata $\sim 120\text{--}160\ \mu\text{m}$ diam]
- 1b. Ascospores 1(–3)-septate; on *Aspicilia* or *Megaspora* spp. 2
- 2a (1b). Ascospores $\sim 22\text{--}31 \times 5\text{--}6\ \mu\text{m}$; asci usually 4-spored *C. wernerii*
[Ascospores largely fusiform, not to noticeably heteropolar, with a somewhat attenuated, frequently slightly curved lower cell; asci $70\text{--}100 \times 8\text{--}11\ \mu\text{m}$; ascomata $150\text{--}260\ \mu\text{m}$ diam; on *Aspicilia calcarea*, *A. contorta*, *A. desertorum*.]
- 2b. Ascospores predominantly smaller; asci usually 6–8-spored. 3
- 3a (2b). Ascospores sole-shaped *C. solearispora*
[Ascospores $\sim 17\text{--}21 \times 5\text{--}6\ \mu\text{m}$, markedly heteropolar with the lower cell $< 1/3$ overall length; asci $50\text{--}70 \times 10\text{--}15\ \mu\text{m}$, 8-spored; ascomata $160\text{--}230\ \mu\text{m}$ diam; on *Aspicilia intermutans*, *A. cinerea*, *A. cupreoglaucia*, sterile *Aspicilia* sp.]
- 3b. Ascospores not sole-shaped 4
- 4a (3b). Ascospores $\sim 18\text{--}24 \times 5\text{--}7\ \mu\text{m}$; asci $70\text{--}110 \times 9\text{--}13\ \mu\text{m}$, usually 6-spored; ascomata $230\text{--}350\ \mu\text{m}$ diam *C. mutabilicola* ined.
[Ascospores ellipsoid; asci ~ 6 -spored; on *Megaspora verrucosa* var. *mutabilis*]
- 4b. Ascospores, asci, and ascomata generally smaller. 5
- 5a (1b). Not cecidiogenous; on *Megaspora verrucosa* *C. verrucosaria*
[Ascospores $\sim 15.5\text{--}19.5 \times 5\text{--}6\ \mu\text{m}$, ellipsoid to fusiform; Asci $65\text{--}95 \times 9\text{--}11\ \mu\text{m}$, elongate subcylindrical, usually 8-spored. Ascomata $130\text{--}200\ \mu\text{m}$ diam.]
- 5b – Cecidiogenous; on *Aspicilia* spp. *C. galligena*
[Ascospores $\sim 14\text{--}19 \times 5\text{--}6\ \mu\text{m}$, oval-ellipsoid or ellipsoid; asci $50\text{--}75 \times 12\text{--}15\ \mu\text{m}$, cylindrical-clavate, usually 6–8-spored; ascomata $120\text{--}190\ \mu\text{m}$ diam.]

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Literature cited

- Arnold F. 1890. Die Lichenen des Fränkischen Jura. Denkschr. K. Bayer. Bot. Ges. Regensburg 6: 1–61. (Separatum: J. & K. Mayr, Stadtamhof. 61 pp.)
- Arnold F. 1896. Lichenologische Ausflüge in Tirol. XXVI. Pians. XXVII. Galtür. XXVIII. Wolkenstein. XXIX. Plansee. Nachträge. Verh. K.-K. Zool.-Bot. Ges. Wien 46: 101–143.
- Berger F, Etayo J. 1998. Beiträge zur Flechtenflora der Kanarischen Inseln. V. Saxicole und muscicole Arten von der Insel La Palma. Österr. Z. Pilzk. 7: 65–90.
- Bilovitz PO, Mayrhofer H. 2008. Zur Diversität lichenisierter Pilze auf der Schneealpe (Nordalpen, Steiermark). – Mitt. Naturwiss. Ver. Steiermark 137: 25–39.
- Blanquez A. 1946. Diccionario Latino-Español. Ed. R. Sopena, Barcelona. 1302 pp.
- Boissière JC, Deruelle S, Roux C. 1989. Liste provisoire des lichens récoltés dans la région de Chamonix (Excursion A.F.L., 1988). – Bull. Inform. Assoc. Franc. Lichénol. 14(2): 5–18.
- Bouly de Lesdain M. 1909. Notes lichénologiques. IX. Bull. Soc. Bot. France 56: 170–175.
- Clauzade G, Roux C. 1976. Les champignons lichénicoles non lichénisés. Univ. des Sciences et Techniques du Languedoc. Lab. Systématique et Géobotanique Méditerranéenne. Montpellier. 110 pp.
- Clauzade G, Roux C. 1985. Likenoj de Okcidenta Eŭropo. Ilustrita determinlibro. Bull. Soc. Bot. du Centre-Ouest, nouv. série, Num. spéc. 7, 893 pp. Royan.
- Clauzade G, Roux C. 1987. Likenoj de Okcidenta Eŭropo. Suplemento 2a. Bull. Soc. Bot. Centre-Ouest, nouv. sér. 18: 177–214.
- Clauzade G, Roux C. 1989. Likenoj de Okcidenta Eŭropo. Suplemento 3a. Bull. Soc. linn. Provence 40: 73–110.
- Clauzade G, Diederich P, Roux C. 1989. Nelikeniĝintaj fungoj likenloĝaj. Ilustrita determinlibro. Bull. Soc. linn. Provence, Num. spécial 1, 142 pp.
- Esnault J. 1985. Le genre *Aspicilia* Massal. (Lichens) en Algérie: étude des caractères taxonomiques et de leur variabilité. Doctoral thesis. Laboratoire de Botanique L. Daniel. Université de Rennes I.
- Grube M, Hafellner J. 1990. Studien an flechtenbewohnenden Pilzen der Sammelgattung *Didymella* (*Ascomycetes*, *Dothideales*). Nova Hedwigia 51(3–4): 283–360.
- Grummann V. 1974. Biographisch-bibliographisches Handbuch der Lichenologie. Verlag J. Cramer, Lehre. ix + 839 pp., pl.
- Hafellner J. 1987. Studien über lichenicole Pilze und Flechten VI. Ein verändertes Gattungskonzept für *Cercidospora*. Herzogia 7: 355–365.
- Hafellner J. 2000. Zur Biodiversität lichenisierter und lichenicoler Pilze in den Eisenerzer Alpen (Steiermark). Mitt. Naturwiss. Ver. Steiermark 130: 71–106.
- Hafellner J. 2002. Zur Diversität lichenisierter Pilze und ihrer Parasiten in den Seckauer Tauern (Ostalpen, Niedere Tauern, Steiermark). Mitt. Naturwiss. Ver. Steiermark 132: 83–137.
- Hafellner J. 2008a. Lichenicolous Biota (Nos 21–60). Fritschiana (Graz) 61: 1–28.

- Hafellner J. 2008b. Zur Diversität lichenisierter und lichenicoler Pilze im Gebiet der Koralpe (Österreich: Kärnten und Steiermark, Slowenien). Mitt. Naturwiss. Ver. Steiermark 138: 29–112.
- Hafellner J, Mayrhofer H. 2007. A contribution to the knowledge of lichenicolous fungi and lichens occurring in New Zealand. In: Kärnefelt I. & Thell, A. (eds.), Lichenological Contributions in Honour of David Galloway. Biblioth. Lichenol. 95: 225–266.
- Hafellner J, Obermayer W. 2007. Flechten und lichenicole Pilze im Gebiet der Stubalpe (Österreich: Steiermark und Kärnten). Mitt. Naturwiss. Ver. Steiermark 136: 5–59.
- Hafellner J, Türk R. 1995. Über Funde lichenicoler Pilze und Flechten im Nationalpark Hohe Tauern (Kärntner Anteil, Österreich). Carinthia II 185/105: 599–635.
- Hafellner J, Türk R. 2001. Die lichenisierten Pilze Österreichs – Eine Checkliste der bisher nachgewiesenen Arten mit Verbreitungsangaben. Stapfia 76: 3–167.
- Hafellner J, Wittmann H. 1996. IAL 3. Excursion 2: Alpine lichens of the central part of the Eastern Alps. Excursion guide. Graz.
- Hafellner J, Kocourková J, Obermayer W. 2004. Records of lichenicolous fungi from the northern Schladminger Tauern (Eastern Alps, Austria, Styria). Herzogia 17: 59–66.
- Hafellner J, Obermayer S, Obermayer W. 2005a. Zur Diversität der Flechten und lichenicolen Pilze im Hochschwab-Massiv (Nordalpen, Steiermark). Mitt. Naturwiss. Ver. Steiermark 134: 57–103.
- Hafellner J, Petutschnig W, Taurer-Zeiner C, Mayrhofer H. 2005b. Zur Flechtendiversität in den Gurktaler Alpen (Kärnten, Steiermark, Salzburg). Herzogia 18: 79–138.
- Hafellner J, Herzog G, Mayrhofer H. 2008. Zur Diversität von lichenisierten und lichenicolen Pilzen in den Ennstaler Alpen (Österreich: Steiermark, Oberösterreich). Mitt. Naturwiss. Ver. Steiermark 137: 131–204.
- Halıcı MG, Hawksworth DL, Aksoy A. 2007. New and interesting lichenicolous fungi records from Turkey. Nova Hedwigia 85(3–4): 393–401.
- Hawksworth DL. 1985. A redistribution of the species referred to the ascomycete genus *Microthelia*. Bull. Brit. Mus. (Nat. Hist.), Bot. Ser. 14(2): 43–181.
- Hawksworth DL, Diederich P. 1988. A synopsis of the genus *Polycoccum* (*Dothideales*) with a key to accepted species. Trans. Br. Mycol. Soc. 90(2): 293–312.
- Keissler Kv. 1930. Die Flechtenparasiten. - Rabenhorst's Kryptogamen-Flora, 2. Aufl., Bd. 8. Akademische Verlagsgesellschaft, Leipzig. 712 pp.
- Kernstock E. 1893. Lichenen von Brixen und Umgebung. Gesammelt von Ludwig Graf Sarnthein, untersucht von. – Z. Ferdinandeums, Innsbruck, 3. Folge, 37: 297–310.
- Lindsay WL. 1869. Enumeration of micro-lichens parasitic on other lichens. Quatern. J. Microsc. Sci. n. s. 9: 49–57, 135–146, 342–358.
- Lumbsch HT, Huhndorf SM. 2007. Outline of *Ascomycota* – 2007. Myconet 13: 1–58.
- Lumbsch HT, Feige GB, Schmitz KE. 1994. Systematic studies in the *Pertusariales* I. *Megasporaceae*, a new family of lichenised Ascomycetes. J. Hattori Bot. Lab. 75: 295–304.
- Navarro-Rosinés P, Roux C, Casares M. 1995. Hongos liquenícolas de *Squamarina* II: Sobre la identidad de "*Didymella*" *crozalsiana* (*Ascomycetes*). Cryptogamie, Bryol. Lichénol. 16(2): 99–103.
- Navarro-Rosinés P, Calatayud V, Hafellner J. 2004. *Cercidospora*. In: Nash T. H. III, Ryan B. D., Diederich P., Gries C. & Bungartz F. (eds.): Lichen Flora of the Greater Sonoran Desert Region, Volume 2. Lichens Unlimited, Arizona State University, Tempe, Arizona, pp. 635–639.
- Nimis PL. 1993. The lichens of Italy, an annotated catalogue. Torino: Museo Regionale di Scienze Naturali. 897 pp.

- Obermayer W. 1999. *Dupla Graecensia lichenum*. (1999). *Fritschiana* (Graz) 21: 13–30.
- Ozenda P, Clauzade G. 1970. *Les Lichens. Étude biologique et flore illustrée*. Masson & Cie éditeurs, Paris. 801 pp.
- Rondon Y. 1969. L'herbier des champignons parasites des lichens de l'abbé L. Vouaux. *Rev. Bryol. Lichénol.* 36: 737–745.
- Santesson R. 1960. Lichenicolous fungi from northern Spain. *Svensk Bot. Tidskr.* 54: 499–522.
- Santesson R. 1993. The lichens and lichenicolous fungi of Sweden and Norway. SBT-förlaget, Lund. 240 pp.
- Svane SJ, Alstrup V. 2004. Some lichenicolous fungi from Iceland. *Acta Bot. Islandica* 14: 53–58.
- Triebel D, Scholz P. 2001. Lichenicolous fungi from Bavaria as represented in the Botanische Staatssammlung München. *Sendtnera* 7: 211–231.
- Vězda A. 1970. Príspevek k poznání lichenikolních hub v Československu III. Beitrag zur Kenntnis der flechtenbewohnenden Pilze aus der Tschechoslowakei III. *Ceská Mykol.* 24: 220–229.
- Vondrák J, Kocourková J, Slavíková-Bayerová S, Breuss O, Sparrius L, Hawksworth DL. 2007. Noteworthy lichens, lichenicolous and other allied fungi recorded in Bohemian Karst, Czech Republic. *Pozoruhodné lišejníky, lichenikolní houby a jiné lišejníkům podobné houby Českého krasu. Bryonora* 40: 31–40.
- Vouaux L. 1912–1914. Synopsis des champignons parasites de lichens. *Bull. Soc. Mycol. France* 28: 177–256 (1912); 29: 33–128, 395–446, 447–494 (1913); 30: 135–198, 281–329 (1914).
- Werner RG. 1937. Recherches phytogéographiques comparées sur la flore cryptogamique de l'Espagne méridionale et du Maroc. *Bull. Soc. Sci. Nat. Maroc* 17: 32–66.
- Werner RG. 1956. Notes de lichénologie libano-syrienne III. *Bull. Soc. Bot. France* 103(7–8): 461–467.
- Wirth V. 1980. *Flechtenflora*. Stuttgart: E. Ulmer. 552 pp.
- Wirth V. 1995. *Flechtenflora*. 2. Auflage. Stuttgart: E. Ulmer. 661 pp.
- Zhurbenko MP. 2002. Lichenicolous fungi of the genus *Cercidospora* (*Dothideales, Ascomycota*) in the north of Russia (Titel translated). *Mikologija i Fitopatologija* 36(1): 3–10.
- Zhurbenko MP. 2004. Lichenicolous and some interesting lichenized fungi from the Northern Ural, Komi Republic of Russia. *Herzogia* 17: 77–86.
- Zhurbenko MP. 2008. Lichenicolous fungi from Russia, mainly from its Arctic. II. *Mycologia Balcanica* 5: 13–22.
- Zhurbenko MP. 2009. Lichenicolous fungi and some lichens from the Holarctic. *Opuscula Philolichenum* 6: 87–120.

A new isidiate species of *Graphis* (lichenised *Ascomycotina*) from China*

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Abstract — This paper describes a third isidiate species with trans-septate spores in the genus *Graphis* sensu Staiger. The new species is from Guangdong Province of China. It is characterized by an isidiate thallus, a completely carbonized exciple with entire lips, trans-septate ascospores, and the absence of lichen substances.

Key words — *Graphis guangdongensis*, *Graphidaceae*, *Ostropales*, *Ascomycota*

Introduction

The members of the *Graphidaceae* (*Ostropales*, lichen forming fungi) are widely distributed in pantropical areas of the world. In the genus *Graphis*, sensu Staiger (Staiger 2002), there are two known isidiate species with trans-septate spores, viz. *G. patwardhanii* C.R. Kulk. 1978 and *G. isidiza* Adaw. & Makhija (Adawadkar & Makhija 2004).

The new isidiate species of the genus, which differs from the two species mentioned above, was collected in China and is described as new to science in the present paper.

Material and methods

The material examined was collected from Guangdong in southern China. A dissecting microscope (TECH XTS-20 and AIGO Digital Viewer GE-5) and a

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compound microscope (OLYMPUS CHB-213) were used for the morphological and anatomical studies. Measurements and illustrations were taken from manual cross-sections of lirellae in tap water. The chemistry was determined by thin-layer chromatography (TLC) (Culberson & Kristensson 1970, Culberson 1972, White & James 1985).

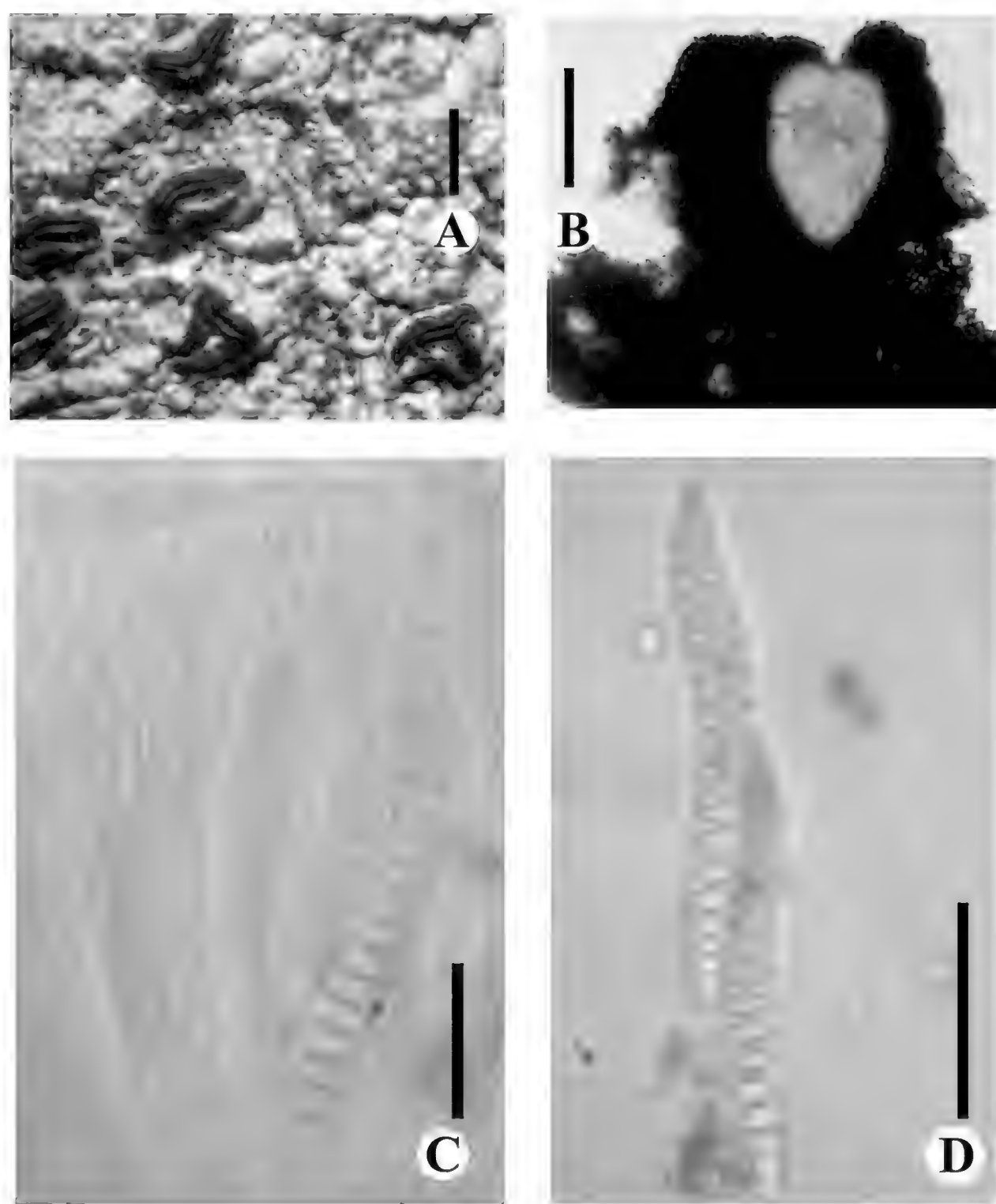


FIG. 1 *Graphis guangdongensis*. A. Habit (bar =1mm); B. A cross section of an apothecium (bar =100 mm); C. An ascus containing ascospores (bar = 50µm); D. Ascospores (bar = 50 µm).

Taxonomy

Graphis guangdongensis Z.F. Jia & J.C. Wei, sp. nov.

FIGURE 1

MYCOBANK MB 514121

Species nova *G. patwardhanii* similis sed excipulo omnino carbonaceo et labello integro differt.

HOLOTYPE: CHINA. provincia Guangdong, comitatus Fengkai, Heishiding, 23°27'N, 113°30'E, alt. 250 m, in cortice arboris latifoliae. X/28/1998. coll. Shou-Yu Guo 2185 (holotypus in HMAS-L X024581, isotypus in LHS).

ETYMOLOGY: The specific epithet “guangdongensis” refers to the place name of the province Guangdong, China, the type locality of the new species.

THALLUS corticolous, pale white to milky white, unevenly thickened, tightly attached to the substratum, distinctly isidiate. Isidia small, globose, or more or less digitiform, 100–150 µm tall. APOTHECIA elongate, 0.5–2.5 mm long, 0.25–0.3 mm wide, simple or rarely slightly branched, erumpent, black, curved and straight, rounded to pointed at the ends, not striate, scattered over the thallus. PROPER EXCIPLE conspicuous, completely carbonized. EPITHECIUM 8–10.5 µm thick, grayish. HYPOTHECIUM brownish, 20–41.5 µm tall HYMENIUM colorless, clear, 160–190 µm tall, I–. PARAPHYSES unbranched, filiform, septate, up to 1.5 µm wide ASCI cylindrical, 110–132 × 22–33 µm, 2–4-spored. ASCOSPORES colourless, long fusiform, 18–20 transverse septate, (65–)75–110 × (8–)11–15.5 µm, I+ blue.

CHEMISTRY: C–, K–, P–; no lichen compounds detected.

REMARKS: The new species is similar to both *Graphis patwardhanii* and *G. isidiza* in having an isidiate thallus and producing trans-septate spores. *Graphis patwardhanii* differs in having a laterally carbonized, 3–6-striate exciple while *G. isidiza* has smaller (21–34 × 4–8 µm) ascospores and contains the lichen compounds constictic acid and stictic acid (Adawadkar & Makhija 2004). *Graphis guangdongensis* is so far known only from the type material.

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Literature cited

- Adawadkar B, Makhija U. 2004. A new isidiate species of *Graphis* from India. *The Lichenologist* 36(6): 361–363.
- Culberson CF, Kristensson H. 1970. A standardized method for the identification of lichen products. *Journal of Chromatography* 46: 85–93.

- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *Journal of Chromatography* 72: 113–125.
- Staiger B. 2002. Die Flechtenfamilie *Graphidaceae*. Studien in Richtung einer natürlicheren Gliederung. *Bibliotheca Lichenologica* 85: 1–526.
- White FJ, James PW. 1985. A new guide to microchemical techniques for the identification of lichen substances. *British Lichen Society Bulletin* 57: 1–41.

New species of *Graphis* and *Hemithecium* (lichenized Ascomycota) from Eastern Himalaya, India

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Abstract — Two new species, *Graphis neoraensis* and *Hemithecium himalayanum* (*Graphidaceae*) are described from the well protected Neora Valley National Park in the Eastern Himalaya, India.

Key words — *Ostropales*, taxonomy

Introduction

Neora Valley National Park is one of the undisturbed natural ecosystems in the Eastern Himalaya. It extends over an 88 sq km area bordering Sikkim and Bhutan in the Darjeeling district of West Bengal State. During lichen survey tours to the park in March 2007 and May 2008 several lichen samples were collected and are now preserved in the BSA herbarium of the Botanical Survey of India. While studying specimens in the lichen family *Graphidaceae*, two species in the genera *Graphis* and *Hemithecium* were found to be new to science, which are described in the present paper. Makhija & Adawadkar (2005a,b), Adawadkar & Makhija (2005, 2006, 2007), and Chitale et al. (2009) made some significant contributions to these genera from India.

Materials and methods

Specimens collected from Neora Valley National Park and deposited in BSA were investigated. External morphological features were observed with an Olympus SZ61 Stereo microscope. Thin hand-cut sections of thalli were mounted in water, 10% KOH solution, Lugol's iodine solution and lactophenol cotton blue (LCB) and examined with a Leica DM 2500 compound microscope. The lichen substances were identified by thin layer chromatography following White & James (1985).

The species

Graphis neoraensis Jagadeesh & G.P. Sinha, sp. nov.

FIG. 1

MYCOBANK MB 514052

Similis *Graphis sikkimensis* sed *ascosporis majoribus et acidum sticticum continens*.

HOLOTYPE – INDIA, West Bengal, Darjeeling district, Neora Valley National Park, Neora riverine forest, Primary rainforest, N 27° 06' 30.3", E 88° 43' 04.0", alt. 2245 m, 17 May 2008, T.A.M. Jagadeesh Ram 4337 (BSA).

ETYMOLOGY: the species epithet refers to the collection site (Neora Valley) of the holotype.

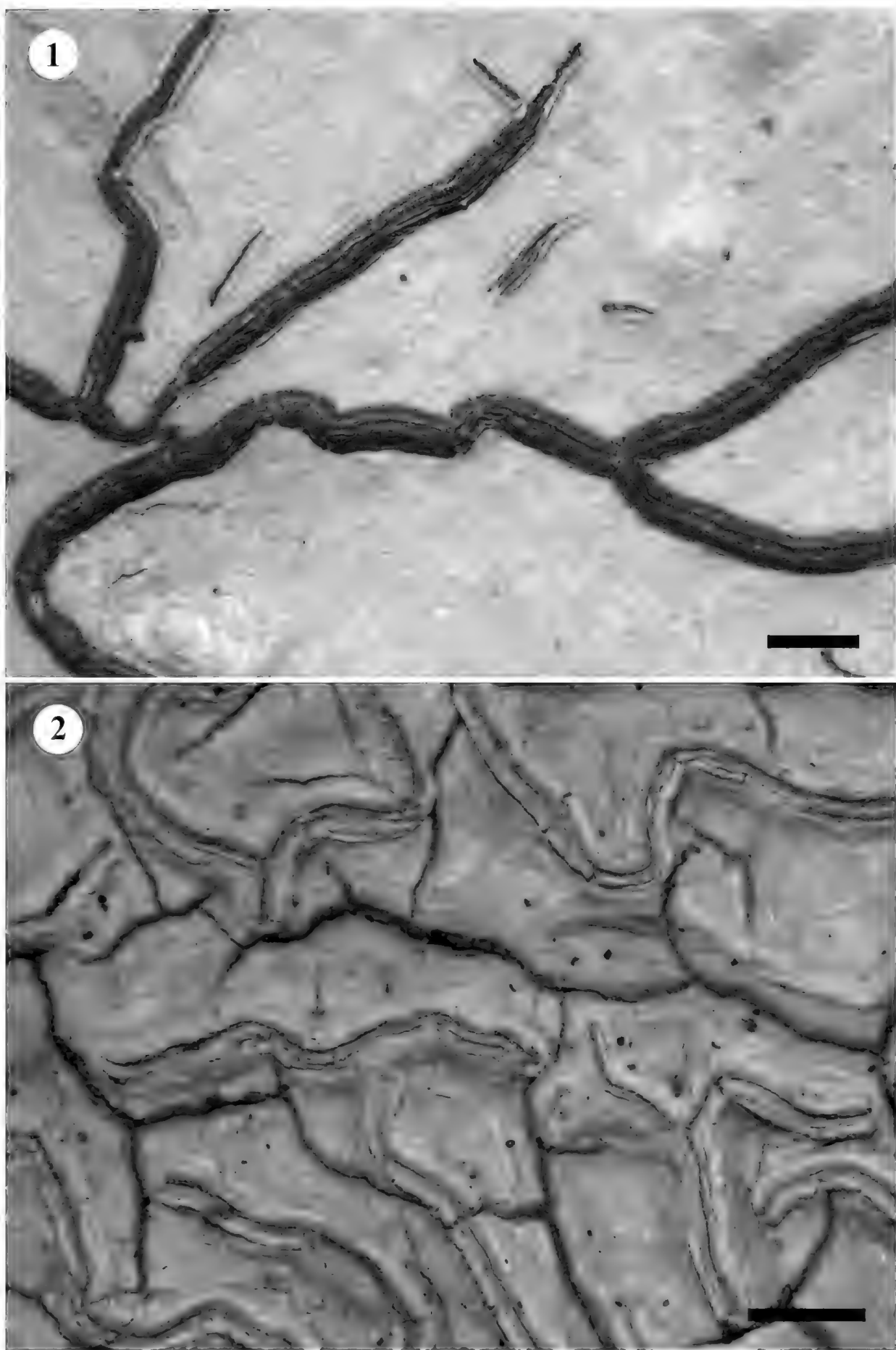
THALLUS crustose, corticolous, endo- to epi-phloeodal, irregular, up to 11 cm across, yellowish grey to yellow brown, smooth, lacking calcium oxalate crystals, ecorticate to corticate, 52–80 µm thick; prothallus distinct, black, up to 3 mm wide; cortex 20–33 µm thick; photobiont layer 16–33 µm thick, photobiont *Trentepohlia*.

ASCOMATA lirellate, numerous, prominent, mostly radially to radially dichotomously branched, occasionally simple to furcate, straight to flexuous, 4–20 mm long, 0.25–0.45 mm wide. DISC narrow slit-like. THALLINE MARGIN distinct, lateral, partly covering the proper excipulum, occasionally absent when old, uneven, often verrucose, occasionally with calcium oxalate crystals in patches. PROPER EXCIPULUM complete, 5–13 striate, apically carbonized, yellowish to orange-brown laterally below the carbonized region and at the base, 100–200 µm thick laterally and 22–45 µm thick at the base. LABIA ± naked, convergent. EPIHYMENIUM brown, 5–7 µm thick. HYMENIUM hyaline, not inspersed, 100–135 µm high, I–. SUBHYMENIUM hyaline, 16–20 µm thick. PARAPHYSES simple, branched at tips, 1.5 µm wide. ASCI clavate to fusiform, 8-spored, 86–120 × 17–20 µm. ASCOSPORES biseriate, hyaline, oblong, not halonate, 12–17 locular, (50–)55–80(–96) × 7–9 µm, I+ blue-violet.

CHEMISTRY – Thallus K+ red, C–, KC–, P+ yellowish, UV–; stictic acid (major) only detected by TLC.

ADDITIONAL SPECIMEN EXAMINED – India, West Bengal, Darjeeling district, Neora Valley National Park, Zero Point – PHE Source foot track, N 27° 05' 10.3", E 88° 43' 17.8", alt. 2461 m, 16 May 2008, Jagadeesh Ram 4286 (BSA).

REMARKS – *Graphis neoraensis* is characterized by the yellowish grey to yellow brown thallus, large radially to radially dichotomously branched lirellae, the 5–13 striate apically carbonized excipulum, the 8-spored asci with 12–17 locular large ascospores, and the presence of stictic acid. It is close to *G. sikkimensis* Nagarkar & Patw. 1982, which is known from the neighbouring Tiger hill of Darjeeling and Sikkim; that species also has a yellowish thallus and long radially branched ascomata with 5–6 striate apically carbonized excipulum but differs in having 7–9 septate, smaller (24–44 × 6–8 µm) ascospores and in lacking



FIGS. 1. *Graphis neoraensis* (holotype). 2. *Hemithecium himalayanum* (holotype). Scale = 1 mm.

lichen substances (Nagarkar & Patwardhan 1982, Adawadkar & Makhija 2007). *Graphis neoraensis* also resembles the morphologically and chemically similar species, *G. vittata* Müll. Arg. 1882, which also occurs in India as well as in Indonesia, China, and Taiwan. *Graphis vittata*, however, differs in having smaller (30–50 µm long) ascospores with fewer (8–12) locules (Müller 1882).

***Hemithecium himalayanum* Jagadeesh & G.P. Sinha, sp. nov.**

FIG. 2

MYCOBANK MB 514055

Similis *Hemithecium laubertianum* sed *hymenio inspersus et ascosporis minoribus*.

HOLOTYPE – INDIA, West Bengal, Darjeeling district, Neora Valley National Park, Mulkharka – Jorepokri foot track, Primary rainforest, N 27° 09' 37.8", E 88° 42' 56.1", alt. 2340 m, 18 May 2008, T.A.M. Jagadeesh Ram 4376 (BSA).

ETYMOLOGY: the species epithet refers to the geographical region of the type collection site (Eastern Himalaya).

THALLUS crustose, corticolous, epiphloeodal, orbicular to irregular, up to 20 cm across, yellow-green, smooth, shiny, cracked, with calcium oxalate crystals in patches, up to 160 µm thick, corticate; prothallus indistinct; cortex 40–78 µm thick; photobiont layer 20–50 µm thick, continuous, photobiont *Trentepohlia*.

ASCOMATA lirellate, erumpent, numerous, dense, simple to branched, flexuous, up to 20 mm long, 0.4–0.6 mm wide. DISC narrow slit-like. THALLINE MARGIN distinct, lateral, partly covering the proper excipulum, with prominent patches of calcium oxalate crystals. PROPER EXCIPULUM 3–5 striate, convergent, pale brown, continuing below the subhymenium, not carbonized, up to 150 µm thick laterally, up to 50 µm thick at the base. EPIHYMENIUM thin, brown, 6–8 µm thick. HYMENIUM hyaline, strongly inspersed, 100–125 µm high, I–. SUBHYMENIUM hyaline, thin, 15–20 µm thick. PARAPHYSES simple, 1–1.5 µm wide. ASCI clavate, 8-spored, 65–100 × 15–17 µm. ASCOSPORES biseriate, hyaline, oblong to oblong-ovoid, not halonate, 6–8 locular, 21–30 × 6.5–8 µm, I+ blue-violet.

CHEMISTRY – Thallus K+ reddish, C–, KC–, P–, UV–; no lichen substances detected by TLC.

ADDITIONAL SPECIMEN EXAMINED – India, West Bengal, Darjeeling district, Neora Valley National Park, PHE Source – Doley foot track, riverine primary rainforest, alt. c. 2150 m, 10 Mar. 2007, Jagadeesh Ram 4008 (BSA).

REMARKS – *Hemithecium himalayanum* is characterized by the epiphloeodal yellow-green thallus, the inspersed hymenium, the 8-spored asci with 6–8 locular small ascospores, and the absence of lichen substances in the thallus. It combines characters found in the allied genera *Hemithecium* and *Pallidogramme*. *Hemithecium*, which usually has a non-inspersed hymenium and hyaline I+ blue-violet ascospores, either lacks lichen substances or produces norstictic acid while *Pallidogramme* has an inspersed hymenium, brownish I+ red-brown

ascospores, and stictic acid and other stictic acid satellites as lichen substances (Lücking & Plata 2008). The hyaline I+ blue-violet ascospores and lack of lichen substances in the thallus support placing the species in *Hemithecium*. *Hemithecium himalayanum* somewhat resembles *H. laubertianum* (Fée) Staiger 2002, another species in the genus that also lacks lichen substances and has fewer ascospore locules; *H. laubertianum*, however, has a non-inspersed, I+ blue-violet hymenium and rather large ($25\text{--}40 \times 8\text{--}14 \mu\text{m}$) ascospores (Staiger 2002).

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Literature cited

- Adawadkar B, Makhija U. 2005. Some trans-septate species of the genera *Hemithecium* and *Platythecium* from India. *Mycotaxon* 92: 387–394.
- Adawadkar B, Makhija U. 2006. New species and new records of *Graphis* from India: transseptate species with completely carbonized exciples and norstictic acid. *Mycotaxon* 96: 51–60.
- Adawadkar B, Makhija U. 2007. New species and new records of *Graphis* from India with partially carbonized exciples and transseptate ascospores. *Mycotaxon* 99: 303–326.
- Chitale G, Makhija U, Sharma B. 2009. New combinations and new species in the lichen genera *Hemithecium* and *Pallidogramme*. *Mycotaxon* 108: 83–92.
- Lücking R, Plata ER. 2008. Clave Guía Ilustrada Para Géneros de *Graphidaceae*. *Glalia* 1: 1–41.
- Makhija U, Adawadkar B. 2005a. Some additions to the *Graphidaceae* in the Andaman Islands, India. *Mycotaxon* 91: 347–352.
- Makhija U, Adawadkar B. 2005b. Some new species of *Graphis* (lichenised Ascomycota) from the Andaman and Nicobar Islands of India. *Mycotaxon* 91: 369–379.
- Müller J. 1882. Lichenologische Beiträge XV. *Flora* 65: 326–337.
- Nagarkar MB, Patwardhan PG. 1982. Notes on some lichens from North East India IV: Genus *Graphis*. *Biovigyanam* 8: 125–131.
- Staiger B. 2002. Die Flechtenfamilie *Graphidaceae*: Studien in Richtung einer natürlicheren Gliederung. *Biblioth. Lichenol.* 85: 1–526.
- White FJ, James PW. 1985. A new guide to the microchemical technique for the identification of lichen substances. *Bull. Brit. Lich. Soc.* 57(suppl.): 1–41.

New species and new records of *Herpothallon* (lichenized Ascomycota) from India

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Abstract — *Herpothallon flavominutum* and *H. himalayanum*, two new lichenized ascomycetes, are described from India. *Herpothallon flavominutum* has a byssoid thallus with granular pseudoisidia and a white prothallus and hypothallus and contains lichexanthone, norlichexanthone, and psoromic acid whereas *H. himalayanum* has a byssoid thallus with irregularly cushion-shaped pseudoisidioid outgrowths and a whitish to lemon yellow hypothallus and contains gyrophoric and lecanoric acids. Three additional *Herpothallon* species, *H. albidum*, *H. cinereum* and *H. philippinum*, are reported as new records for India.

Key words — Arthoniales, Arthoniaceae, eastern India

Introduction

Herpothallon is a recently reinstated lichen genus in the family Arthoniaceae (Aptroot et al. 2009) and includes 29 species world-wide. The genus is characterized by the byssoid prothallus and hypothallus, ± felty heteromerous thallus with felty pseudoisidia, pustules, soredia-like granules, or minute granules, and *Trentepohlia* as photobiont. Following the above work, Jagadeesh Ram et al. (2009) reported two new species and two new records from India. In this paper we propose an additional two new species and report three new records of *Herpothallon* from eastern India. The new species are described below and brief notes on the new records are provided.

Materials and methods

Specimens collected from eastern India and deposited in BSA were investigated. External morphological features were observed with an Olympus SZ61 stereo microscope. Thin hand-cut sections of thalli were mounted in water, 10% KOH solution, Lugol's iodine solution and lactophenol cotton blue (LCB) and examined with a Leica DM 2500 compound microscope. The lichen substances were identified by thin layer chromatography (Orange et al. 2001) and high performance liquid chromatography (Elix et al. 2003).

The new species

Herpothallon flavominutum Jagadeesh, G.P. Sinha & Elix, sp. nov.

FIG. 1

MYCOBANK MB 514058

Thallus corticola, epiphloeodes, byssoideus, griseo-luteus; pseudoisidia densa, granulares, 0.02–0.06 mm diam.; asci non visi; substantiae lichexanthone, norlichexanthone et psoromicum continens.

HOLOTYPE – INDIA, Sikkim, Gangtok, Baluwakhani, Botanical Survey of India, Sikkim Himalayan Circle campus, alt. c. 1700 m, on *Alnus nepalensis*, 24 November 2006, G.P. Sinha 3743 (BSA).

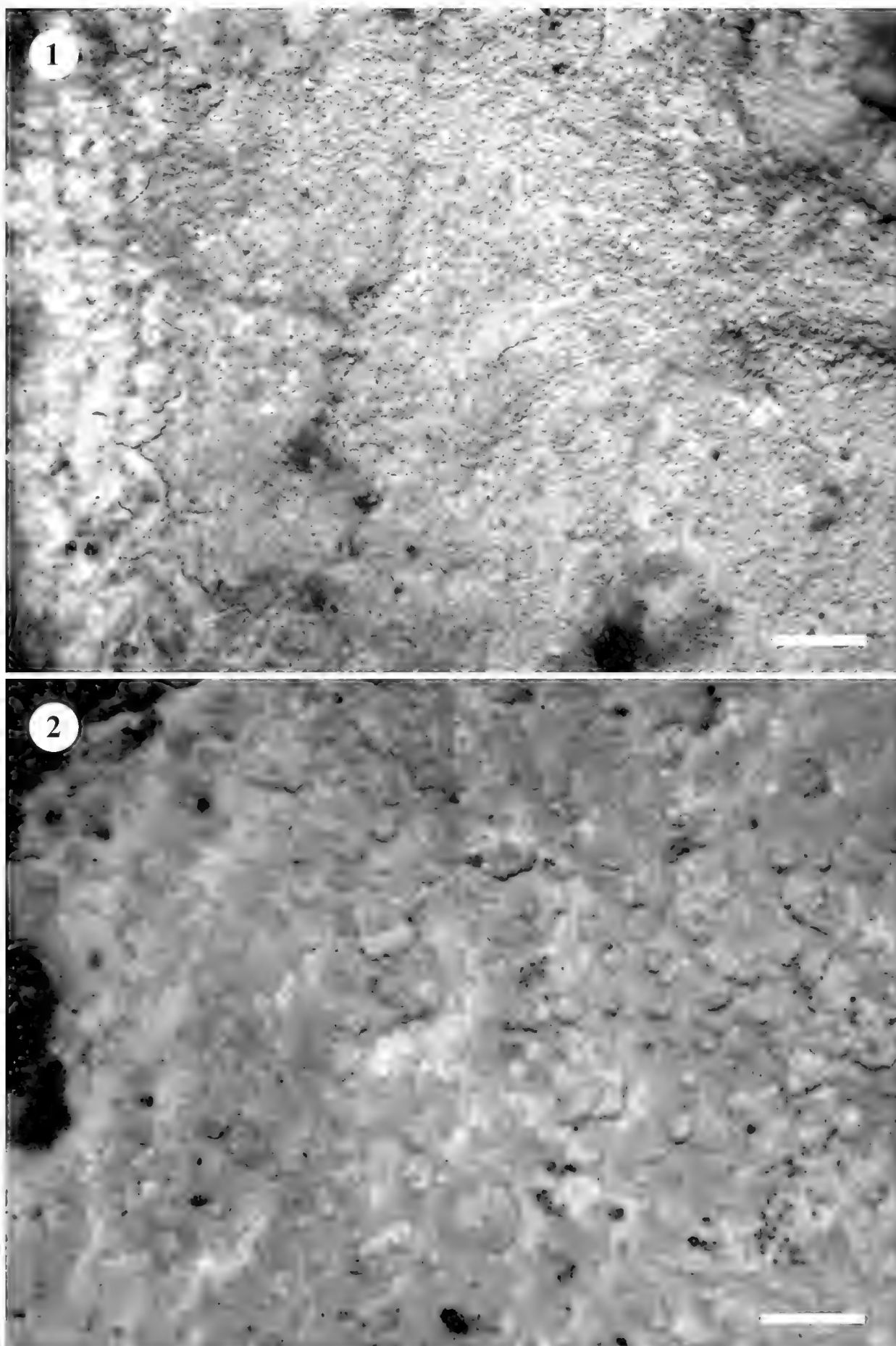
ETYMOLOGY: the species epithet refers to the UV+ yellow thallus and the very small pseudoisidioid outgrowths.

THALLUS corticolous, epiphloeodal, \pm loosely adpressed, orbicular to suborbicular, 2–5 cm wide, greyish yellow, byssoid, not flaking off, felty, 100–160 μ m thick, with calcium oxalate crystals; crystals few to many, 3–20 μ m wide. HYPOTHALLUS below the entire thallus, byssoid, whitish, mainly of radiating loosely interwoven hyphae, hyphae 1.5–2.5 μ m wide. PROTHALLUS white, byssoid, mainly of radiating loosely interwoven hyphae, 1.5–2.5(–3) mm wide. PSEUDOISIDIA numerous, dense, minute, felty with projecting hyphae, granular, globose, subglobose to \pm cylindrical, 0.02–0.06 mm diam., or 0.03–0.08(–0.1) mm long, 0.02–0.06 mm wide. PHOTOBIONT *Trentepohlia*, in short, irregular threads, single to aggregated. ASCI and PYCNIDIA not seen.

CHEMISTRY – Thallus K+ orange, C–, KC–, P–, UV+ yellow; I+, KI+ blue in patches (section). HPLC: lichexanthone (major), norlichexanthone (major) and psoromic acid (minor).

PARATYPE – INDIA, Meghalaya, Shillong, Laitumkhrah, Botanical Survey of India, Eastern Circle campus, near Orchidarium, alt. c. 1435 m, on *Acacia* sp., 14 February 2008, T.A.M. Jagadeesh Ram 4154 (BSA).

REMARKS – *Herpothallon flavominutum* is characterized by the byssoid thallus with granular pseudoisidia and the presence of lichexanthone, norlichexanthone, and psoromic acid. *Herpothallon adnatum* G. Thor, *H. brialmonticum* Aptroot & Elix 2009, *H. corallinum* G. Thor 2009, *H. granulare* (Sipman) Aptroot & Lücking 2009, and *H. hypoprotocetraricum* G. Thor 2009 are other species having somewhat similar pseudoisidia but differ in chemistry, prothallus, and hypothallus characters. *Herpothallon elegans* G. Thor 2009 is the only other species that contains lichexanthone as a major substance, but it is distinguished by having additionally constictic, stictic, and salazinic acids as well as a reddish brown prothallus and cylindrical pseudoisidia up to 0.5×0.1 mm (Aptroot et al. 2009). At present *H. flavominutum* is known from the Khasi hills (Shillong) and Sikkim in the Eastern Himalaya.



FIGS. 1–2. 1. *Herpothallon flavominutum* (holotype). 2. *Herpothallon himalayanum* (holotype).
Scale = 1 mm.

***Herpothallon himalayanum* Jagadeesh & G.P. Sinha, sp. nov.**

FIG. 2

MYCOBANK MB 514059

Thallus corticola, epiphloeodes, byssoideus, albo-griseus ad flavo-griseus; hypothallus albus ad flavus, byssoideus; pseudoisidia irregularis, usque ad 1 × 0.5 mm; asci non visi; acidum gyrophoricum, lobaricum et substantia ignota continens.

HOLOTYPE – INDIA, West Bengal, Darjeeling district, Neora Valley National Park, Neora riverine rainforest, N 27° 05' 49.2", E 88° 43' 29.7", alt. 2163 m, 16 May 2008, T.A.M. Jagadeesh Ram 4310 (BSA).

ETYMOLOGY: the species epithet refers to the geographical region of the type collection site (Eastern Himalaya).

THALLUS crustose, corticolous to muscicolous, up to 5 cm wide, loosely appressed to the substrate, byssoid, firm to flaking off, dull, felty, pale yellow mineral grey to grey-green, with scattered red granules, verrucose to pustulate, up to 200 µm thick in section, hyphae 1.5–2.5 µm wide, with few to numerous calcium oxalate crystals; crystals scattered, 3–10 µm wide. HYPOTHALLUS below the entire thallus, byssoid, whitish to mostly lemon yellow, composed of 1.5–2.5 µm wide hyphae. PROTHALLUS dirty white, composed of interwoven and radiating hyphae, up to 1.5 mm wide. PSEUDOISIDIOID OUTGROWTHS numerous, scattered to closely aggregated, irregularly cushion-shaped, fluffy-felty with many projecting hyphae, paler than the thallus, up to 1 × 0.5 mm. PHOTOBIONT *Trentepohlia*, in short, irregular threads, single to aggregated. ASCI not seen. PYCNIDIA hemispherical, dark brown to black, developing on the pseudoisidioid outgrowths, 0.05–0.07 mm diam.; CONIDIA not observed.

CHEMISTRY – Thallus K–, C+ red, KC+ red, P–, UV–, I+ and KI+ blue; hypothallus in pigmented parts K+ blood-red. TLC: gyrophoric acid (major), lecanoric acid (minor) and an unidentified yellow pigment (major) are present.

REMARKS – The thallus of *H. himalayanum* is characterized by irregularly cushion-shaped, pseudoisidioid outgrowths, a whitish to lemon yellow hypothallus, and the presence of gyrophoric and lecanoric acids. The pseudoisidioid outgrowths are often closely aggregated to give the appearance of a distinctly verrucose surface when old and have occasionally minute cylindrical to spherical pseudoisidioid outgrowths arising from the verrucose surface that often bear pycnidia. Externally *H. himalayanum* resembles *H. albidum*, which is distinguished by a different chemistry and blue-green hypothallus. *Herpothallon fertile* Aptroot & Lücking 2009, the other similar species with a lemon yellow hypothallus and similar chemistry, differs in having a fertile I– and KI– thallus and lacking pseudoisidia and calcium oxalate crystals (Aptroot et al. 2009).

New records

***Herpothallon albidum* (Fée) Aptroot, Lücking & G. Thor 2009**

This pantropical species has been found in a montane riverine rainforest in the Eastern Himalaya. It is characterized by the loosely attached, byssoid thallus with scattered calcium oxalate crystals, a blue-green byssoid hypothallus, a whitish prothallus, irregularly cushion-shaped fluffy-felty pseudoisidia, and the presence of psoromic acid and pigmentosin D.

SPECIMEN EXAMINED – INDIA: West Bengal: Darjeeling district, Neora Valley National Park, Neora river bank, N 27° 06' 44.7", E 88° 43' 00.8", alt. 2260 m, 17 May 2008, Jagadeesh Ram 4345 (BSA).

***Herpothallon cinereum* G. Thor 2009**

This species, previously known from Venezuela, has been found at a single locality in the Eastern Himalaya where it grew on the dry bark of a pine tree. It is characterized by the loosely to firmly attached thallus with many calcium oxalate crystals, a whitish hypothallus and prothallus, cylindrical pseudoisidia up to 0.5×0.1 mm, and the presence of confluent acid.

SPECIMEN EXAMINED – INDIA: West Bengal: Darjeeling district, Kalimpong, campus of the Divisional Forest Manager Office, alt. 1206 m, on dry bark of *Pinus*, 6 Mar. 2007, Jagadeesh Ram 3882 (BSA).

***Herpothallon philippinum* (Vain.) Aptroot & Lücking 2009**

This widely distributed pantropical species has been found in the Cachar hills of Assam in a Tea Garden. It is characterized by the loosely to firmly attached thallus with many calcium oxalate crystals, whitish hypothallus and prothallus, cylindrical pseudoisidia up to 1×0.1 mm, and the presence of gyrophoric acid.

SPECIMEN EXAMINED – INDIA: Assam: North Cachar Hills district, Borjalanga, Rosekandy Tea Estate, on shade tree, 15 Jan. 2005, V.N. Singh 1813 (BSA).

Acknowledgments

The authors thank Dr M. Sanjappa, Director, Botanical Survey of India, Kolkata and Dr. K.P. Singh, Additional Director, Botanical Survey of India, Central Regional Centre, Allahabad for facilities. The authors also gratefully acknowledge Emeritus Prof. John A. Elix, Australian National University, Canberra Australia, and Dr. D.K. Upreti, National Botanical Research Institute, Lucknow, India, for presubmission review. One of the authors (TAMJR) is grateful to Ministry of Environment & Forests, New Delhi for financial assistance under the AICOPTAX scheme.

Literature cited

- Aptroot A, Thor G, Lücking R, Elix JA, Chaves JL. 2009. The lichen genus *Herpothallon* reinstated. *Bibliotheca Lichenologica* 99: 19–66.
- Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. *Bibliotheca Lichenologica* 86: 1–7.
- Jagadeesh Ram TAM, Sinha GP, Singh KP. 2009. New species and new records of *Cryptothecia* and *Herpothallon* (*Arthoniales*) from India. *Lichenologist* 41: 605–613.
- Orange A, James PW, White FJ. 2001. Microchemical methods for the identification of lichens. British Lichen Society, UK.

Macrofungal diversity of Adıyaman Province (Turkey)

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Abstract — This study was carried out on macrofungal specimens collected from Adıyaman province of Turkey during 2001–2009; a total of 189 taxa were identified. Including 33 taxa previously reported, a list of 222 taxa belonging to 98 genera of 42 families has been compiled. Three taxa, *Conocybe pilosella*, *Coprinopsis gonophylla*, and *Stropharia melanosperma* are new records for the macromycota of Turkey. The complete list is available on: <http://www.mycotaxon.com/resources/weblists.html>.

Key words — biodiversity, mushrooms

Introduction

According to available records, studies on the macromycota of Turkey started in the first quarter of 20th century and there has been an increase in the number of such studies, especially in the last three decades. By the end of 2008, about 1814 macromycete taxa reported from Turkey in 416 published studies by foreign and Turkish researchers have been compiled in checklists (Solak et al. 2007, Sesli & Denchev 2008). Solak et al. (2009) and Kaya (2009a) also added to the list. Considering the macrofungal diversity estimates of Mueller et al. (2007) regarding the plant/macrofungus ratios of temperate regions, there is still much to be done to obtain the overall macrofungal data of Turkey. To date, Kaya et al. (2004) and Kaya (2005, 2009b,c) have published studies with data on collections from Besni, Gölbaşı, Tut districts, and Nemrut Mount National Park within Adıyaman. The current study was based on macrofungi collected from the rest of Adıyaman province and aims to determine the fungal diversity of the region and contribute to the knowledge of the macromycota of Turkey.

Adıyaman is a Southeastern Anatolian vilayet of Turkey with a surface area of 7614 km² situated in C7 square according to Davis' grid square system (Davis 1965). The central district is located on the foothills of the Southeastern Taurus Mountains. The province generally has a very rough terrain and the land, which generally descends from north to south, is broken up by many deep gorges.

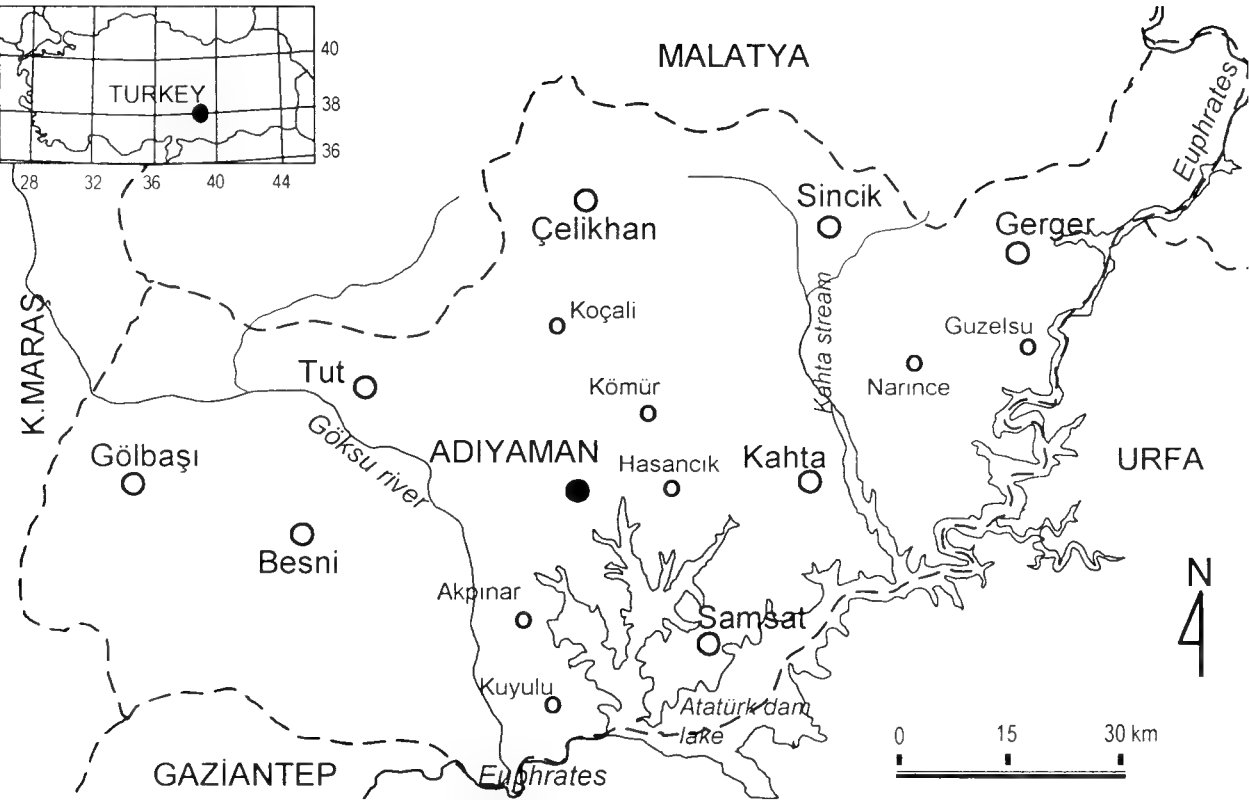


FIGURE 1. Macrofungi collecting area

The province is bordered by the Taurus Mountains to the north and the river Euphrates to the south. Adiyaman has a Mediterranean climate (Emberger's formula; Akman 1999) characterized by cold rainy winters and dry summers, with an annual average temperature of 17.2°C and annual rainfall of ~685 mm. The river Euphrates, Atatürk Dam Lake, and many streams that flow into the lake from the southern foothills of Taurus Mountains are among the important hydrologic factors affecting the climate for macrofungal growth. The plant cover in Adiyaman is a mixture of Mediterranean, Southeastern, and Eastern vegetation. Forest areas are characterised mainly by *Quercus* and planted *Pinus brutia* populations. Members of the genera *Pistacia*, *Rhus*, *Paliurus*, *Prunus*, *Morus*, *Crataegus*, *Acacia*, *Cedrus*, *Amygdalus*, *Nerium*, and *Rosa* are other representative tree populations in the region. Various species of *Salix*, *Populus*, *Platanus*, and *Tamarix* are dominant along the river and stream banks.

Materials and methods

Periodic fungal inventories were conducted between October 2001 and May 2009; macrofungal samples were collected from 110 localities in Adiyaman Province, Turkey. The majority of collection sites were in naturally growing oak forests, planted pine forests, meadows, pastures, and streamsides. During field studies, color photographs of the specimens were taken for macroscopic descriptions and placed in specially prepared paper boxes together with

the recorded field data. Macroscopic and microscopic investigations were carried out later in the herbarium. Measurements of basidiospores and other microscopic structures were made from slide preparations mounted in 3% KOH. Specimens were identified according to Phillips (1981), Moser (1983), Miller & Miller (1988), Breitenbach & Kränzlin (1984–2005), Candusso & Lanzoni (1990), Buczacki (1992), Jordan (1995), Bessette et al. (1997), and Antonín & Noordeloos (1997) or comparisons with our previously identified samples and VANDF herbarium collections. Fruit bodies were preserved by drying on a specially designed low heat electric dryer and deposited in the fungarium of Adıyaman University Education Faculty, Adıyaman, Turkey.

Results

Determined 189 taxa are listed alphabetically with habitat, locality, collection date, and accession numbers (K: Kaya). Author citations are abbreviated according to <http://www.indexfungorum.org/AuthorsOfFungalNames.htm> and the systematics of the taxa are in accordance with Cannon & Kirk (2007), Kirk et al. (2008), and Index Fungorum (www.speciesfungorum.org; accessed 29 May 2009). The 33 taxa previously found and reported in the province (Kaya et al. 2004, Kaya 2005, 2009b,c), were added to the list together with their references. The checklist currently contains 222 taxa representing 98 genera and 42 families. Taxa include 22 *Ascomycota* (7 *Morchellaceae*, 6 *Helvellaceae*, 4 *Pezizaceae*, 4 *Pyronemataceae*, 1 *Caloscyphaceae*) and 200 *Basidiomycota* (27 *Psathyrellaceae*, 24 *Strophariaceae*, 20 *Bolbitiaceae*, 20 *Agaricaceae*, 18 *Tricholomataceae*, 12 *Inocybaceae*, 9 *Pluteaceae*, 9 *Polyporaceae*, 9 *Marasmiaceae*, 7 *Mycenaceae*, 5 *Entolomataceae*, 3 *Geastraceae*, 3 *Hymenochaetaceae*, 3 *Pleurotaceae*, 3 *Russulaceae*, 2 *Boletaceae*, 2 *Ganodermataceae*, 2 *Gomphidiaceae*, 2 *Hygrophoraceae*, 2 *Physalacriaceae*, 2 *Suillaceae*, 1 *Amanitaceae*, 1 *Auriscalpiaceae*, 1 *Clavulinaceae*, 1 *Cortinariaceae*, 1 *Cyphellaceae*, 1 *Diplocystidiaceae*, 1 *Hydnangiaceae*, 1 *Hygrophoropsidaceae*, 1 *Lyophyllaceae*, 1 *Meruliaceae*, 1 *Paxillaceae*, 1 *Rhizopogonaceae*, 1 *Sclerodermataceae*, 1 *Stereaceae*, 1 *Tapinellaceae*, 1 *Thelephoraceae*).

Conocybe pilosella (Pers.) Kühner 1935, *Coprinopsis gonophylla* (Quél.) Redhead et al. 2001, and *Stropharia melanosperma* (Bull. ex Pers.) Gillet 1878 are new records for the macromycota of Turkey.

Acknowledgments

I would like to thank Adıyaman University Research Fund for supporting the project EFBAP 2008-1 from which some of the data was obtained. And also thanks to Prof. Vladimir Antonín, Prof. Fahrettin Gücin, Prof. Mustafa Işıloğlu, and Dr. Shaun Pennycook for their helpful comments and careful review.

Literature cited

- Akman Y. 1999. İklim ve Biyoiklim. Ankara, Kariyer Matbacılık Ltd.
- Antonín V, Noordeloos ME. 1997. A monograph of *Marasmius*, *Collybia* and related genera in Europe. Part 2: *Collybia*, *Gymnopus*, *Rhodocollybia*, *Crinipellis*, *Chaetocalathus*, and additions to *Marasmiellus*. Libri Botan. 17: 1-256. Eching. München, Ihw-Verlag.
- Bessette AE, Bessette AR, Fischer DW. 1997. Mushrooms of northeastern North America. Hong Kong, Syracuse University Press.
- Breitenbach J, Kränzlin F. 1984–2005. Fungi of Switzerland, vols. 1–6 Lucerne, Verlag Mykologia.
- Buczacki S. 1992. Mushrooms and toadstools of Britain and Europe. London, W Collins Sons & Co Ltd.
- Candusso M, Lanzoni G. 1990. *Lepiota*. Saronno, Libreria editrice Biella Giovanna.
- Cannon PF, Kirk PF. 2007. Fungal families of the world. Wallingford, CAB International.
- Davis PH. 1965. Flora of Turkey and the East Aegean Islands. Vol. 1. Edinburgh, Edinburgh Univ Press.
- Jordan M. 1995. The encyclopedia of fungi of Britain and Europe. Devon, David & Charles Book Co.
- Kaya A, Akan Z, Demirel K. 2004. A Checklist of Macrofungi of Besni (Adıyaman) District. Turkish Journal of Botany 28: 247–251.
- Kaya A. 2005. Macrofungi Determined in Gölbaşı (Adıyaman) District. Turkish Journal of Botany 29: 45–50.
- Kaya A. 2009a. Macromycetes of Kahramanmaraş Province (Turkey). Mycotaxon 108: 31–34.
- Kaya A. 2009b. Macrofungi of Göksu River Basin (Adıyaman-Türkiye), In: Ivanova, D (ed.), Plant, fungal and habitat diversity investigation and conservation. Proceedings of IVth Balkan Botanical Congress, Sofia 2006. pp. 450–455.
- Kaya A. 2009c. Macrofungal diversity of Nemrut Mount National Park and its environs (Adıyaman-Turkey). African Journal of Biotechnology 8: 2978-2983.
- Kirk PF, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the fungi, 10th ed. Wallingford, CAB International.
- Miller OK, Miller HH. 1988. Gasteromycetes. Eureka, Mad River Pres.
- Moser M. 1983. Keys to agarics and boleti (*Polyporales*, *Boletales*, *Agaricales*, *Russulales*). Stuttgart, Gustav Fischer Verlag.
- Mueller GM, Schmit JP, Leacock PR, Buyck B, Cifuentes J, Desjardin DE, Halling RE, Hjortstam K, Iturriaga T, Larsson KH, Lodge DJ, May TW, Minter D, Rajchenberg M, Redhead SA, Ryvarden L, Trappe JM, Watling R, Wu Qiuxin. 2007. Global diversity and distribution of macrofungi. Biodiversity and Conservation 16: 37–48.
- Phillips R. 1981. Mushrooms and other fungi of Great Britain and Europe. London, Pan Books Ltd.
- Sesli E, Denchev CM. 2008. Checklists of the myxomycetes, larger ascomycetes, and larger basidiomycetes in Turkey. Mycotaxon 106: 65–68.
- Solak MH, Allı H, Işıloğlu M, Kalmış E. 2009. Some new records of *Inocybe* (Fr.) Fr. from Turkey. Turkish Journal of Botany 33: 65–69.
- Solak MH, Işıloğlu M, Kalmış E, Allı H. 2007. Macrofungi of Turkey, Checklist, Volume I Bornova-Izmir, Üniversiteler Ofset.

Substitute names for later homonyms of five species and validation of the names of eight species of fossil fungi from Indian Tertiary sediments

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Abstract — Substitute names are proposed for the later homonyms of five accepted species of fossil fungi recorded from Indian Tertiary sediments: *Diporicellaesporites samantiae* (= *D. elsikii* B. Samant & Tapaswi), *Monoporisorites circularis* (= *M. hammenii* B. Samant & Tapaswi), *Multicellaesporites kumarii* (= *M. elsikii* (Ramanujam & Srisailam) P. Kumar), *Pluricellaesporites guptae* (= *P. minutus* A. Gupta), and *Pluricellaesporites suratensis* (= *P. elsikii* B. Samant & Tapaswi). In addition, the author provides information regarding repository of the holotypes to validate eight species names and propose new names to replace two original epithets (in parentheses) that are already in use for different taxa in the same genus: *Brachysporisorites magnus*, *Colligerites trochus*, *Dicellaesporites elsikii*, *Diporisorites bhavnagarensis* (“*D. granulatus* B. Samant”), *Multicellaesporites dilcheri*, *M. psilatus* (“*M. elongatus* B. Samant”), *Phragmothyrites ramanujamii*, and *Pluricellaesporites globatus*.

Key words — fossil fungal spores, microthyriaceous fungi, species nomenclature, Tertiary, India

Introduction

During palynological research on Indian Tertiary sediments, the author encountered names of five species of fossil fungi that are later homonyms; i.e. each name is spelled exactly like a name based on a different type that was previously and validly published for the taxon of the same rank. Such later homonyms are illegitimate and are to be rejected under Articles 45.3 and 53.1 of the International Code of Botanical Nomenclature (McNeill & al. 2006). These species names are therefore replaced by substitute names (*nomina nova*).

Substitute names

Diporicellaesporites samantiae R.K. Saxena, **nom. nov.**

MYCOBANK MB 515005

= *Diporicellaesporites elsikii* B. Samant & Tapaswi, Gondwana Geol. Mag.
15(2): 25–26, fig. 2.2. 2000, non Mart.-Hern. & Tom.-Ort. 1989.

ETYMOLOGY: The epithet honours Dr. Bandana Samant of the Department of Geology, Banaras Hindu University, Varanasi, India.

***Monoporisorites circularis* R.K. Saxena, nom. nov.**

MYCOBANK MB 515007

= *Monoporisorites hammenii* B. Samant & Tapaswi, Gondwana Geol. Mag. 15(2): 28, fig. 2.5. 2000, non Mart.-Hern. & Tom.-Ort. 1989.

ETYMOLOGY: The epithet refers to the circular shape of the fungal spores.

***Multicellaesporites kumarii* R.K. Saxena, nom. nov.**

MYCOBANK MB 515008

= *Staphlosporonites elsikii* Ramanujam & Srisailam, Botanique 9: 122, pl. 1, figs. 6–7. 1980.

= *Multicellaesporites elsikii* (Ramanujam & Srisailam) P. Kumar, Rev. Palaeobot. Palynol. 63: 23. 1990, non R.K. Kar & R.K. Saxena 1976.

ETYMOLOGY: The epithet honours Dr. Pramod Kumar of the Birbal Sahni Institute of Palaeobotany, Lucknow, India.

***Pluricellaesporites guptae* R.K. Saxena, nom. nov.**

MYCOBANK MB 515010

= *Pluricellaesporites minutus* A. Gupta, Tertiary Research 21: 138, pl. 2, fig. 22, text-fig. 2c. 2002, non Kalgutkar & Janson. 2000.

ETYMOLOGY: The epithet honours Dr. Asha Gupta of the Birbal Sahni Institute of Palaeobotany, Lucknow, India.

***Pluricellaesporites suratensis* R.K. Saxena, nom. nov.**

MYCOBANK MB 515012

= *Pluricellaesporites elsikii* B. Samant & Tapaswi, Gondwana Geol. Mag. 15(2): 28–29, fig. 2.12. 2000, non Kalgutkar 1997.

ETYMOLOGY: The epithet refers to the Surat district of Gujarat (western India), where the type locality of the species is situated.

Validation of species names

Two species described by Samant (2000), “*Diporisorites granulatus*” and “*Multicellaesporites elongatus*” would also have been later homonyms, but the names were not validly published because the place of deposition of the type was not stated. New names for these species are validly published below.

***Diporisorites bhavnagarensis* R.K. Saxena, sp. nov.**

MYCOBANK MB 515013

VALIDATING DESCRIPTION AND ILLUSTRATION: “*Diporisorites granulatus* B. Samant” in Geophytology 28: 12, 14, pl. 1, fig. 10. 2000.

HOLOTYPE: Pl. 1, fig. 10, slide no. C-70, 3; Geology Department, Nagpur University, Nagpur, India.

ETYMOLOGY: In reference to the Bhavnagar district of Gujarat (western India), where the type locality of the species is situated.

Samant (2000) described the new species “*Diporisorites granulatus*” but did not validly publish the name as she did not state where the type is stored (McNeill & al. 2006: Art. 37.7). The species is here validated by the addition of the holotype location, obtained from personal communication with Dr. Bandana Samant.

Samant’s epithet “*granulatus*” cannot be used because of the existence of *Diporisorites granulatus* P. Ke & Z.Y. Shi 1978.

***Multicellaesporites psilatus* R.K. Saxena, sp. nov.**

MYCOBANK MB 515014

VALIDATING DESCRIPTION AND ILLUSTRATION: “*Multicellaesporites elongatus* B. Samant” in *Geophytology* 28: 14, pl. 1, fig. 14. 2000.

HOLOTYPE: Pl. 1, fig. 14, slide no. C-111, 6; Geology Department, Nagpur University, Nagpur, India.

ETYMOLOGY: In reference to the psilate spore wall of the fungal spores.

Samant (2000) described the new species “*Multicellaesporites elongatus*” but did not validly publish the name, as she did not cite where the type is stored (McNeill & al. 2006: Art. 37.7). The species is here validated by the addition of the holotype location, obtained from personal communication with Dr. Bandana Samant.

The epithet “*elongatus*” cannot be used because of the existence of *Multicellaesporites elongatus* Sheffy & Dilcher 1971.

Samant (2000) also described the following six species, all of which are invalid because their protologues contained no information regarding holotype locations (McNeill & al. 2006: Art. 37.7). All names are validated below, with each ascribed to B. Samant based on the original descriptions and illustrations. The holotypes are those designated by Samant and are stored in the Geology Department, Nagpur University, Nagpur, India (Dr. Bandana Samant, personal communication).

***Brachysporisorites magnus* B. Samant, sp. nov.**

MYCOBANK MB 515015

VALIDATING DESCRIPTION AND ILLUSTRATION: *Geophytology* 28: 11–12, pl. 1, figs. 1–2. 2000.

HOLOTYPE: Pl. 1, fig. 1, slide no. C-113, 2; Geology Department, Nagpur University, Nagpur, India.

***Colligerites trochus* B. Samant, sp. nov.**

MYCOBANK MB 515017

VALIDATING DESCRIPTION AND ILLUSTRATION: *Geophytology* 28: 12, pl. 1, fig. 3. 2000.

HOLOTYPE: Pl. 1, fig. 3, slide no. C-69, 4; Geology Department, Nagpur University, Nagpur, India.

***Dicellaesporites elsikii* B. Samant, sp. nov.**

MYCOBANK MB 515018

VALIDATING DESCRIPTION AND ILLUSTRATION: *Geophytology* 28: 12, pl. 1, fig. 7. 2000.

HOLOTYPE: Pl. 1, fig. 7, slide no. C-115, 6; Geology Department, Nagpur University, Nagpur, India.

***Multicellaesporites dilcheri* B. Samant, sp. nov.**

MYCOBANK MB 515016

VALIDATING DESCRIPTION AND ILLUSTRATION: *Geophytology* 28: 14–15, pl. 1, fig. 12. 2000.

HOLOTYPE: Pl. 1, fig. 12, slide no. C-112, 6; Geology Department, Nagpur University, Nagpur, India.

***Phragmothyrites ramanujamii* B. Samant, sp. nov.**

MYCOBANK MB 515003

VALIDATING DESCRIPTION AND ILLUSTRATION: *Geophytology* 28: 15, pl. 1, fig. 21. 2000.

HOLOTYPE: Pl. 1, fig. 21, slide no. C-112, 6; Geology Department, Nagpur University, Nagpur, India.

***Pluricellaesporites globatus* B. Samant, sp. nov.**

MYCOBANK MB 515002

VALIDATING DESCRIPTION AND ILLUSTRATION: *Geophytology* 28: 15, pl. 1, figs. 22–23. 2000.

HOLOTYPE: Pl. 1, fig. 22, slide no. C-116, 8; Geology Department, Nagpur University, Nagpur, India.

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Literature cited

- Gupta A. 2002. Algal/fungal spores from Early Tertiary sediments of Sirmaur District, Himachal Pradesh, India. *Tertiary Research* 21(1–4): 123–154.
- Kalgutkar RM. 1997. Fossil fungi from the Lower Tertiary Iceberg Bay Formation, Eureka Sound Group, Axel Heiberg Island, Northwest Territories, Canada. *Rev. Palaeobot. Palynol.* 97: 197–226.
- Kalgutkar RM, Jansonius J. 2000. Synopsis of fossil fungal spores, mycelia and fructifications. *AASP Contrib. Ser. No.* 39: 1–423.

- Kar RK, Saxena RK. 1976. Algal and fungal microfossils from Matanomadh Formation (Palaeocene), Kutch, India. *Palaeobotanist* 23(1): 1–15.
- Ke P, Shi ZY. 1978. Early Tertiary spores and pollen grains from the coastal region of the Bohai (in Chinese). Academy of Petroleum Exploration, Development and Planning Research of the Ministry of Petroleum and Chemical Industries and the Nanjing Institute of Geology, and Paleontology, Chinese Academy of Sciences, Kexue Chubanshe, Peking, 177 p.
- Martínez-Hernández E, Tomasini-Ortiz AC. 1989. Spores, hyphae and other fungal remains from the Fuentes-Rio Escondino Carboniferous basin (Campanian-Maastrichtian), Coahuila State, Mexico. *Universidad Nacional Autonoma de Mexico, Instituto de Geologia, Revista* 8: 235–242.
- McNeill J, Barrie FR, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC., Skog JE, Wiersema JH, Turland NJ (eds). 2006. International Code of Botanical Nomenclature (Vienna Code), adopted by the Seventeenth International Botanical Congress Vienna, Austria, July 2005. A. R. G. Gantner Verlag, Ruggell, Liechtenstein. [Regnum Veg. 146].
- Ramanujam CGK, Srisailam K. 1980. Fossil fungal spores from the Neogene beds around Cannanore in Kerala state. *Botanique* 9: 119–138.
- Samant B. 2000. Fungal remains from the Bhavnagar lignite, Gujarat. *Geophytology* 28: 11–18.
- Samant B, Tapaswi PM. 2000. Fungal remains from the Surat lignite deposits (Early Eocene) of Gujarat, India. *Gondwana Geol. Mag.* 15(2): 25–30.
- Sheffy MV, Dilcher DL. 1971. Morphology and taxonomy of fungal spores. *Palaeontographica Abt. B* 133: 34–51.

Conidial fungi from the semi-arid Caatinga biome of Brazil. New species and new records of *Helicosporium*

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Abstract —A new helicosporous fungus, *Helicosporium vesiculiferum*, is described based on morphological characters. It was found on a decaying twig of an unidentified dicotyledonous plant from the semi-arid region, Northeast of Brazil. The new species is illustrated with light micrographs and scanning electron microscopy. *Helicosporium vesiculiferum* is characterized by the presence of vesicles on apex of the conidiophores. Seven helicosporous species are briefly described, of which *H. virescens* and *H. aureum* are new records from Brazil, *H. panacheum* and *H. gracile* are reported for the first time in South America, and *H. nizamabadense* is new for the American continent. A key to all *Helicosporium* species is included.

Key words — anamorphic fungi, taxonomy

Introduction

Helicosporous fungi are defined by their coiled asexual spores (Tsui & Berbee 2006) and are considered aero-aquatic (Dix & Webster 1995). They are commonly found on substrates with abundant water (Mercado-Sierra 1982). In the present study these fungi were found in a semi-arid region, demonstrating the plasticity and survival capacity of helicosporous fungi in an inhospitable environment with low water availability and high temperatures.

Since Link (1809) described the first helicosporous species, *Helicomycetes roseus*, several studies have been devoted to this group (e.g., Morgan 1892;

Linder 1929; Moore 1953, 1955; Goos 1980, 1985a,b,c, 1986, 1989, 1990). There are about 240 described species in 45 genera (Saccardo 1886, Linder 1929, Goos 1987, Zhao et al. 2007).

Phylogenetic studies are clarifying the relationship between the major genera of helicosporous fungi and their teleomorph connections. Tsui et al. (2006) analyzed rDNA of species of *Helicomycetes* Link, *Helicoma* Corda, and *Helicosporium* Nees and verified that although all were related to *Tubeufia* Penz. & Sacc. sensu M.E. Barr, they are not monophyletic. Tsui & Berbee (2006) confirmed and extended the polyphyletism to *Helicodendron* Peyronel and *Helicoon* Morgan and suggested that the convergent form of the conidia is a possible adaptation to dispersion in aquatic environments.

Helicosporium is characterized by the presence of long and conspicuous conidiophores and conidia that are relatively thin-walled and hygroscopic (Goos 1989). The species are mainly distinguished by the morphology of conidia (diameter, filament width and number of coils), conidiophores, conidiogenous cells, and colony color (Goos 1989). Currently 21 species are included in the genus (Zhao et al. 2007)

Up to now, nine helicosporous fungi have been reported for Brazil: *Dichotomophthoropsis nympheae* (F.V. Rand) M.B. Ellis (Cavalcanti & Milanez 2007), *Hiospira jambosae* Bat. et al. (Batista et al. 1964), *Helicoma bambusae* Henn. (Hennings 1902), *H. palmarum* G.Z. Zhao et al. (Samuels et al. 1978, as *Helicomycetes* sp.), *Helicomycetes roseus* Link (Goos 1985b), *Helicosporium griseum* and *H. guianense* Linder (CBS 2009), *H. pannosum* (Sivanesan 1984), and *Xenosporium berkeleyi* (M.A. Curtis) Piroz. (Mendes et al. 1998, as *Xenosporella berkeleyi* (M.A. Curtis) Linder).

Previous studies of leaf litter conidial fungi from Caatinga biome have demonstrated the richness of this region (Castañeda-Ruiz et al. 2006; Cruz et al. 2007 a, b; Gusmão et al. 2008; Leão-Ferreira et al. 2008). During a recent survey an interesting specimen of *Helicosporium* was found. It does not resemble hitherto described species and is proposed here as new.

Materials and methods

The Program of Research in Biodiversity of the Brazilian semi-arid (PPBIO/Semi-árido) is investigating the biodiversity in Caatinga biome. This biome is considered part of a phytogeographical unit of South America called the neotropical seasonally dry tropical forests (Pennington et al. 2000, Prado 2000). It is characterized by high annual average temperatures (26–28°C) and a low precipitation (300–1000 mm/year) that is usually concentrated within 3–5 months; droughts are common (Sampaio 1995).

Samples of plant litter were collected in separate paper bags and taken to the laboratory where each was incubated at 25°C in Petri dishes within 170 L plastic chambers containing 200 ml sterile water and 2 ml glycerol. The plant material was screened at regular intervals for microfungi. Mounts were prepared in polyvinyl alcohol-glycerol

(8 g per 100 ml H₂O, 5 ml glycerol) and deposited in the Herbarium of Universidade Estadual de Feira de Santana (HUEFS).

Taxonomy

Helicosporium vesiculiferum A.C. Cruz & Gusmão sp. nov.

FIGS.1–9

MYCOBANK MB512999

COLONIAE in substrato naturali effusae, albae. MYCELIUM partim superficiale et partim in substrato immersum, ex hyphis ramosis, septatis, pallide brunneis laevibus, 3–6 µm latis compositum. CONIDIOPHORA ex hyphis oriunda, macronematosa, mononematosa, 4–12-septata, simplicia vel interdum ramosa prope basem, erecta, recta vel flexuosa, laevia, brunnea, pallide brunnea vel subhyalina ad apicem, 32.5–155 × 3–7.5 µm; vesicula in apice, plerumque praesentia, globosa, subhyalina, 5–9 × 4.5–8 µm; rami 1–2-septata, laeves, brunnea vel pallide brunnea ad apicem, 10–35(–80) × 2.5–6 µm. CELLULAE CONIDIOGENAE polyblasticae, in conidiophoris incorporatae, intercalares et terminales, cylindricae, laevia, brunneae vel pallidae brunneae; denticulae 0.8–2 × 0.7–2 µm. CONIDIA holoblastica, solitaria, sicca, acropleurogena, 10–15-septata, helicoidea, laevia, hyalina, 11–18 µm diam, filamenta conidica 1–1.5 µm crassa, in 2–3.5 spiris convolute.

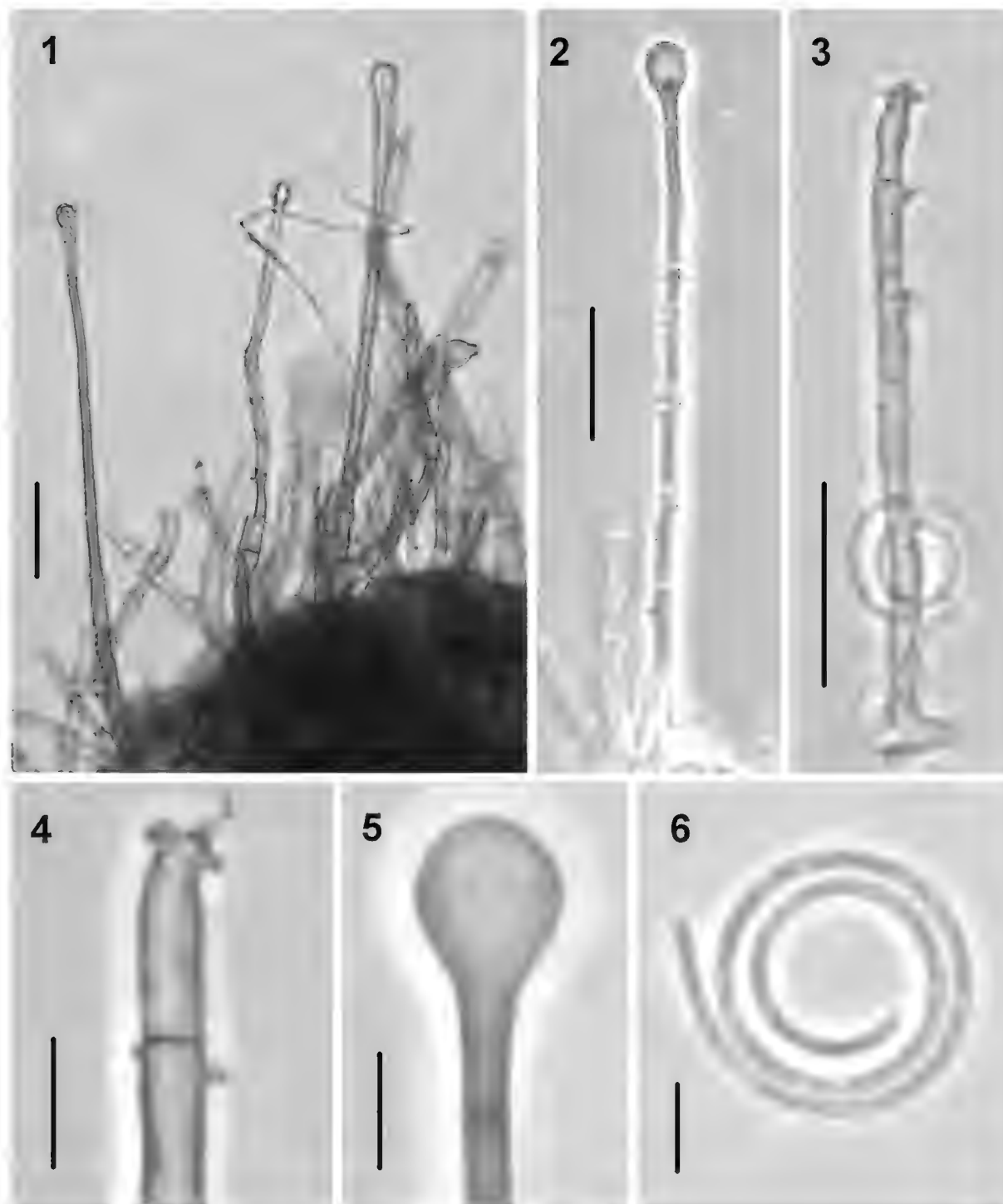
HOLOTYPUS: BRAZIL. BAHIA: Senhor do Bonfim, in ramulis emortuis angiospermae ignotae, 25.IX.2006, A.C.R. Cruz, HUEFS 129360.

ETYMOLOGY: Latin, *vesiculiferum* = carrying vesicles.

COLONIES on natural substrate effuse, white. MYCELIUM superficial and immersed. HYPHAE septate, branched, smooth, pale brown, 3–6 µm diam. CONIDIOPHORES distinct, mononematous, 4–12-septate, simple or occasionally branched near the base, erect, straight or flexuose, smooth, brown, becoming pale brown towards subhyaline apex, 32.5–155 × 3–7.5 µm; vesicle usually present at the apex, globose, pale brown to subhyaline, 5–9 × 4.5–8 µm; branches 1–2-septate, smooth, brown to pale brown, 10–35(–80) × 2.5–6 µm. CONIDIOGENOUS CELLS polyblastic, arise from creeping mycelium, from conidiophores or branches, intercalary or terminal, integrated, cylindrical, smooth, brown to pale brown; denticles, 0.8–2 × 0.7–2 µm. CONIDIA holoblastic, acropleurogenous, 10–15-septate, helical, smooth, hyaline, 11–18 µm diam., conidial filament 1–1.5 µm wide, coiled 2–3.5 times.

OTHER MATERIAL EXAMINED: BRAZIL. BAHIA: Morro do Chápeu, on decaying twig, 12.II.2009, T.S. Santa Izabel, HUEFS 141556.

COMMENTS: *Helicosporium vesiculiferum* is distinguished from other species in the genus by the presence of a vesicle at the conidiophore apex. Only four species produce conidia acropleurogenously: *H. gracile*, *H. griseum*, *H. guianense*, and *H. lumbricopsis*. *Helicosporium griseum* and *H. lumbricopsis* have conidiophores that are branched and often anastomosing, and can be differentiated easily from *H. vesiculiferum* (Berkeley 1874, Linder 1929). *Helicosporium guianense* possess branches along the tall conidiophores (Linder 1929). *Helicosporium gracile* is distinguished by yellow colony and absence of vesicles (Morgan 1892, Goos 1989).



FIGS. 1–6. Light micrographs of *Helicosporium vesiculiferum* (from holotype).
 1. General aspect on natural substrate; 2–3. Conidiophores with and without vesicles;
 4–5. Detail of the conidiophore apex; 6. Conidium
 (Bars 1–3= 20 μ m, 4–6= 5 μ m)

Other species found in semi-arid region

Helicosporium aureum (Corda) Linder, Ann. Mo. bot. Gdn. 16: 279. 1929.

TEL.: *Acanthostigma scopulum* (Cooke & Peck) Peck, Bull. New York State Mus. 1: 22. 1887.

COLONY yellow. CONIDIOPHORES 147–255 \times 4–5.5 μ m. CONIDIOGENOUS CELLS tooth-like or bladder-like, 4.5–13.5 \times 2.5–3.5 μ m. CONIDIA pleurogenous,

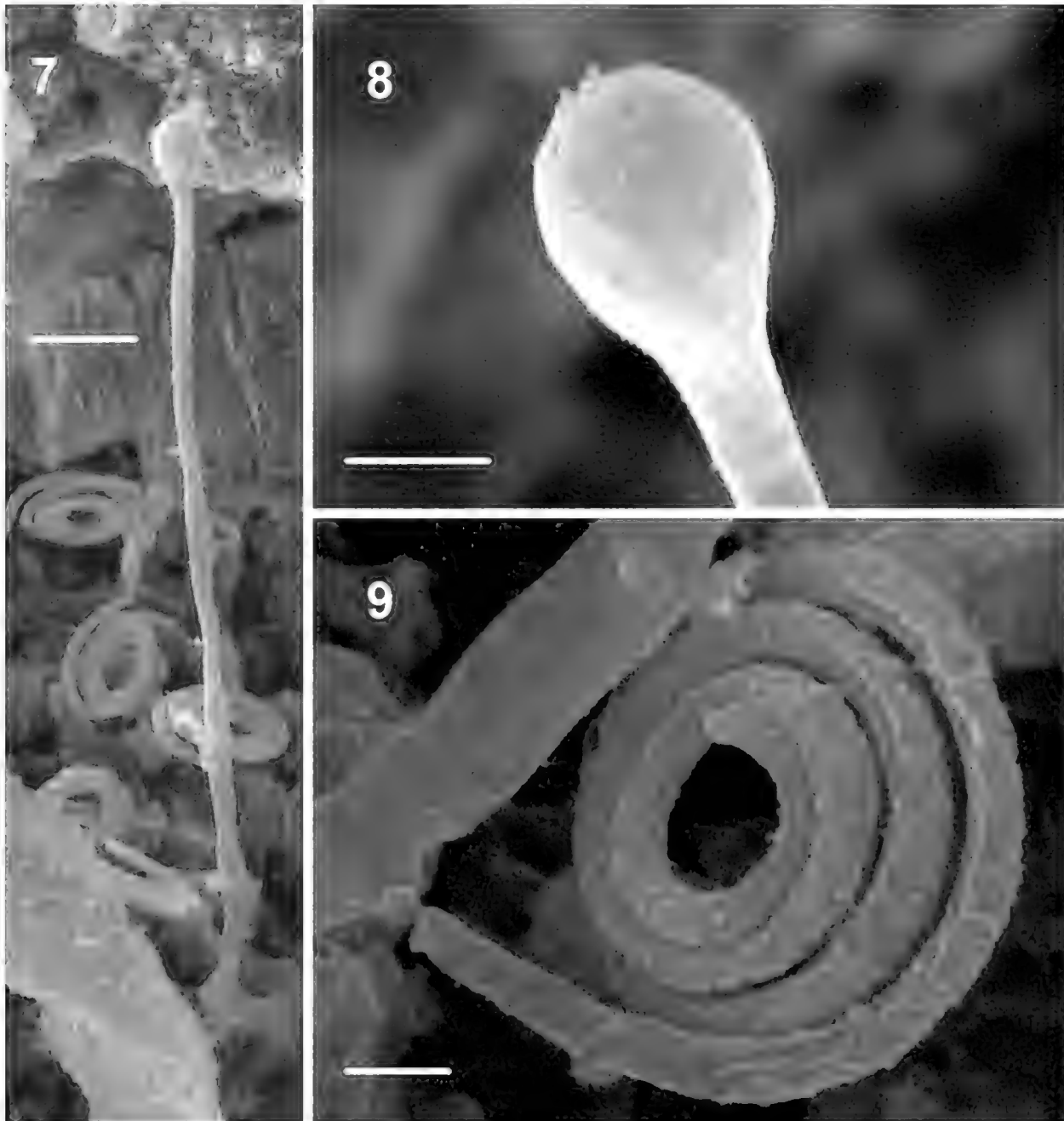


FIG. 7–9. Scanning Electron Microscope micrographs of *Helicosporium vesifuliferum*.
7. Conidiophore; 8. Vesicle; 9. Detail of the secession of conidium.
(Bars fig. 7= 10 μm , 8= 3 μm , 9= 2 μm)

9–20-septate, 10.5–15 μm diam., filament width 1–1.7 μm , number of coils 2.5–4 times.

SPECIMENS EXAMINED: BRAZIL. BAHIA: Pilão Arcado, on dead bark, 16.II.2007. A.C.R. Cruz, HUEFS 129346; Senhor do Bonfim, “Carrapichel”, on decaying twig, 9.X.2006, A.C.R. Cruz, HUEFS 129347.

DISTRIBUTION: Argentina, Australia, Austria, Belize, Brazil, China, Czech Republic, formerly USSR, Japan, Pakistan, Panama, New Zealand, South Africa, USA (CBS 2009, Goos 1989, Farr & Rossman 2009, Morris 1978, Romero & Pildain 2004, Zhao et al. 2007).

Helicosporium aureum is similar to *H. decumbens*, *H. guianense* and *H. hiospiroides* B.S. Reddy et al. in possessing discrete, polyblastic conidio-

genous cells. *Helicosporium decumbens* and *H. hiospiroides* are distinguished by conidia diameter. *Helicosporium guianense* develops branches along its conidiophores. The Brazilian specimens are consistent with the descriptions given by Linder (1929), Goos (1989), and Zhao et al. (2007) regarding the absence of apical branches on conidiophores. *Helicosporium aureum* is recorded for the first time for Brazil.

Helicosporium gracile (Morgan) Linder, Ann. Missouri Bot. Gard. 16: 281. 1929.

COLONY yellow. CONIDIOPHORES 25.5–150 × 3–6 µm. CONIDIOGENOUS CELLS tooth-like. CONIDIA acropleurogenous, 12–15-septate, 12–15µm diam., filament width 1–1.5 µm, number of coils 2–3.5 times.

SPECIMENS EXAMINED: BRAZIL. BAHIA: Morro do Chapéu, on dead leaves, 07.X.2008. T.S. Santa Izabel, HUEFS 141555.

DISTRIBUTION: Africa, Brazil, China, USA (Goos 1989, Linder 1929, Zhao et al. 2007).

The characteristics observed on the examined specimen are included within the morphological variation for the species (Linder 1929, Goos 1989, Zhao et al. 2007). *Helicosporium gracile* is closely related to *H. guianense*, *H. aureum*, and *H. virescens*. However, *H. guianense* differs from *H. gracile* by consistent branches along the conidiophores. *Helicosporium aureum* can be separated by bladder-like conidiogenous cells and larger conidiophores and *H. virescens* has tooth or bladder-like conidiogenous cells and larger conidiophores (Goos 1989, Zhao et al. 2007). This species is reported for the first time in South America.

Helicosporium griseum Berk. & M.A. Curtis, Grevillea 3: 51. 1874.

[non. *H. griseum* (Bonord.) Sacc. 1886]

COLONY pinkish. CONIDIOPHORES 159–390 × 3–5 µm. CONIDIOGENOUS CELLS tooth-like. CONIDIA pleurogenous, 15–25-septate, 11.5–15 µm diam., filament width 1–1.5 µm, number of coils 3.5–4 times.

SPECIMENS EXAMINED: BRAZIL. BAHIA: Jeremoabo, on dead fruit, 18.I.2007, A.C.R. Cruz, HUEFS 129350; Senhor do Bonfim, on dead fruit, 28.IX.2006, A.C.R. Cruz, HUEFS 129351; on decaying twig, 28.IX.2006 A.C.R. Cruz, HUEFS 129352. PERNAMBUCO, Buíque, on rotten leaf, 21.VIII.2006 A.C.R. Cruz, HUEFS 129353.

DISTRIBUTION: Australia, Belgium, Brazil, Canada, China, Costa Rica, Cuba, Czech Republic, formerly USSR, Germany, Hungary, Japan, Mexico, New Guinea, New Zealand, Panama, South Africa, Taiwan, USA (CBS 2009, Cooper 2005, Delgado-Rodriguez et al. 2002, Farr & Rossman 2009, Goos 1989, Heredia et al. 1995, Mercado-Sierra et al. 1997, Paulus et al. 2006, Révay 1998, Tsui et al. 2006, Zhao et al. 2007)

Helicosporium griseum is characterized by much branched conidiophores that frequently anastomose. The conidia are smaller in diameter than those cited by Linder (1929), Goos (1989), and Mercado-Sierra (1984) but are similar to

those reported by Zhao et al. (2007). *Helicosporium lumbricopsis* resembles *H. griseum* but is distinguished by the size of the conidia filament, diameter, and stouter conidiophores (Linder 1929, Zhao et al. 2007). This species was collected in Brazil under the name *H. griseum* (Bonord.) Sacc. and deposited at Centraalbureau voor Schimmelcultures (CBS) by R.F. Castañeda Ruiz (CBS 2009). According to Castañeda Ruiz (pers. comm.), the culture produces velvety colonies and anastomosing conidiophores and so is believed to represent *H. griseum* Berk. & M.A. Curtis.

Helicosporium nizamabadense P. Rag. Rao & D. Rao, Mycopathol. Mycol. Appl. 24: 34. 1964.

COLONY white. CONIDIOPHORES 60–155 × 2–3.5 µm. CONIDIOGENOUS CELLS tooth-like. CONIDIA pleurogenous, 15–24 µm diam., filament width 1–3 µm, number of coils 3–4.5 times.

SPECIMENS EXAMINED: BRAZIL. BAHIA: Serra do Ramalho, on decaying leaves of unidentified dicotyledonous plant, 07.I.2008, S.M. Leão-Ferreira, HUEFS 136881.

DISTRIBUTION: Brazil, India (Rao & Rao 1964).

The examined material has a white colony and conidia are produced from distinct denticles on conidiogenous cells (Rao & Rao 1964). *Helicosporium dentophorum* G.Z. Zhao et al., *H. sympodiophorum* G.Z. Zhao et al., and *H. talbotii* Goos (Goos 1989, Zhao et al. 2007) have similar denticles. However, *H. dentophorum* differs by the presence of smaller conidiophores and bigger conidia, *H. sympodiophorum* has bigger conidiophores and conidia, and *H. talbotii* has conidia with narrower filaments. This is the first record for the American continent.

Helicosporium panacheum R.T. Moore, Mycologia 46: 92, 1954.

COLONY white. CONIDIOPHORES 35–135 × 3–4.5 µm. CONIDIOGENOUS CELLS tooth-like. CONIDIA pleurogenous, multiseptate, 12–16 µm diam., filament width 1–1.5 µm, number of coils 2–3.5 times.

SPECIMENS EXAMINED: BRAZIL. BAHIA, Jeremoabo, “Mata das Pororocas”, on dead bark, 16.I.2007, A.C.R. Cruz, HUEFS 129348; Senhor do Bonfim, “fazenda Passaginha”, on dead bark, 5.X.2006, A.C.R. Cruz, HUEFS 129349.

DISTRIBUTION: Brazil, Canada, China, Japan, Mexico, Taiwan, USA, (Arias et al. 2000, CBS 2009, Chang 2001, Goos 1989, Moore 1954, Zhao et al. 2007).

The specimens examined have conidia smaller than in the original description (Moore 1954) but possess the typical characteristics of the species, having hyaline, branched conidiophores at apex and conidia that are white in mass. Zhao et al. (2007) described the same species with wider conidiophores. *Helicosporium panacheum* is reported for the first time in South America.

Helicosporium pannosum (Berk. & M.A. Curtis) R.T. Moore, Mycologia 49: 582. 1957.

TEL.: *Thaxteriella helicoma* (W. Phillips & Plowr.) J.L. Crane, Shearer & M.E. Barr, Can. J. Bot. 76: 610. 1998.

COLONY brown. CONIDIOPHORES $95\text{--}215 \times 6\text{--}7.5 \mu\text{m}$. CONIDIOGENOUS CELLS tooth-like. CONIDIA pleurogenous, 25–50-septate, $34.5\text{--}45 \mu\text{m}$ diam., filament width $3\text{--}4.5 \mu\text{m}$, number of coils 1.5–4 times.

SPECIMENS EXAMINED: BRAZIL. BAHIA, Senhor do Bonfim, “fazenda Passaginha”, on decaying fruit, 5.X.2006, A.C.R. Cruz, HUEFS 129354.

DISTRIBUTION: Argentina, Australia, Brazil, Chile, China, Cuba, Guiana, Haiti Japan, New Zealand, Papua New Guinea, Seychelles Islands, Sri Lanka, Suriname, Tanzania, Thailand, United Kingdom, USA (Barr 1980, CBS 2009, Delgado-Rodríguez et al. 2002, Farr & Rossman 2009, Hughes 1978, Linder 1929, Matsushima 1975, Pinruan et al. 2007, Romero 1983, Sivanesan 1984, Tsui et al. 2001).

Helicosporium pannosum has a very wide widest conidia filament. The conidia of the material examined are smooth, but the specimens examined by Goos (1989) are minutely echinulate. *Helicosporium pannosum* is close to *H. hongkongense* K.M. Tsui et al. with a similar conidia filament width, but its conidiophores are always simple and conidia are subhyaline to yellowish (Tsui et al. 2001). Conidia are smaller than material studied by Zhao et al. (2007).

Helicosporium virescens (Pers.) Sivan., Bitunicate Ascomycetes and their Anamorphs (Vaduz): 591. 1984.

TEL.: *Tubeufia cerea* (Berk. & M.A. Curtis) Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1, 128: 562. 1919.

COLONY yellow. CONIDIOPHORES $125\text{--}375 \times 3\text{--}6 \mu\text{m}$. CONIDIOGENOUS CELLS tooth-like. CONIDIA pleurogenous, multiseptate, $7.5\text{--}13 \mu\text{m}$ diam., filament width $0.75\text{--}1.2 \mu\text{m}$, number of coils 2–3.5 times.

SPECIMENS EXAMINED: BRAZIL. BAHIA: Campo Formoso, “Mata da Esterzinha”, on decaying twig, 19.IX.2006, A.C.R. Cruz, HUEFS 129355; Jeremoabo, on dead bark, 17.I.2007 A.C.R. Cruz, HUEFS 129356; Senhor do Bonfim, “Carrapichel”, on decaying spathe of *Syagrus coronata* (Mart.) Becc., 9.X.2006, A.C.R. Cruz, HUEFS 129357; Senhor do Bonfim, “Serra da Maravilha”, on dead bark, 11.X.2006, A.C.R. Cruz, HUEFS 129358. PERNAMBUCO, Buíque, on rotten leaf, 11.X.2006, A.C.R. Cruz, HUEFS 129359.

DISTRIBUTION: Austria, Belgium, Brazil, Canada, China, Costa Rica, Cuba, France, Germany, Guiana, Hungary, India, Lithuania, Mexico, Netherlands, Poland, Republic of Belarus, Thailand, United Kingdom, USA (Barr 1980, Farr & Rossman 2009, Goos 1989, Heredia et al. 1995, Linder 1929, Mercado-Sierra et al. 1997, 1998, Révay 1998, Sivanesan 1984, Tsui et al. 2006, Yurchenko 2001, Zhao et al. 2007).

The characteristics observed on the specimens examined are included within the morphological variation of the species (Goos 1989, Zhao et al. 2007). *Helicosporium virescens* differs from *H. aureum* and *H. murinum* Goos by conidiophores that are mostly unbranched. This species was found for the first time for Brazil.

Key to species of *Helicosporium*

- 1a. Conidia borne acrogenously2
- 1b. Conidia borne acropleurogenously3
- 1c. Conidia borne pleurogenously5
- 2a. (1a). Conidiophores less than 40 µm long, conidia coiled 2–2.25 times
..... *H. dentophorum*
- 2b. Conidiophores more than 40 µm long, conidia coiled 3.5–4 times
..... *H. sympodiophorum*
- 3a. (1b). Conidia more than 20 µm diam. *H. panacheum*
- 3b. Conidia less than 20 µm diam.4
- 4a. (3b). Vesicle absent at the apex of conidiophores *H. gracile*
- 4b. Vesicles usually present at the apex of conidiophores *H. vesiculiferum*
- 5a. (1c). Conidiogenous cells bladder-like. *H. hiospiroides*
- 5b. Conidiogenous cells tooth-like and bladder-like6
- 5c. Conidiogenous cells tooth-like9
- 6a. (5b). Conidia less than 10 µm diam *H. decumbens*
- 6b. Conidia more than 10 µm diam7
- 7a. (6b). Conidiophores mostly unbranched. *H. virescens*
- 7b. Conidiophores mostly branched.8
- 8a. (7b). Conidiophores often branched and entangled above. *H. aureum*
- 8b. Conidiophores branched along the mains axis. *H. guianense*
- 9a. (5c). Two kinds of conidiophores (macro and micro) *H. indicum*
- 9b. One kind of conidiophores10
- 10a. (9b). Conidiophores consistently branched, anastomosing frequently11
- 10b. Conidiophores simple, sparsely branched, or occasionally anastomosing12
- 11a. (10a). Conidiophores subhyaline to dark brown, ascending or more
or less erect *H. griseum*
- 11b. Conidiophores dark, erect, at first simple, later branching *H. lumbricopsis*
- 12a. (10b). Conidiophores mostly colorless, rarely pale brown13
- 12b. Conidiophores pale brown to brown14
- 13a. (12a). Conidia 10–15 µm diam *H. pallidum*
- 13b. Conidia 18–28 µm diam *H. nizamabadense*
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2–2.7 µm thick. *H. phragmitis*
- 18a. (14b). Conidia more than 60 µm diam *H. raghuveeri*
- 18b. Conidia less than 60 µm diam. 19
- 19a. (18b). Conidiophores simple, conidia subhyaline to yellowish ... *H. hongkongense*
- 19b. Conidiophores simple or branched from basal parts, conidia
subhyaline to pale brown. *H. pannosum*

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Literature cited

- Arias RM, Heredia G, Estebanez MR. 2000. Primer registro para México de cinco especies de hongos conidiales helicospóricos. *Rev. Mex. Mic.* 16: 27–32.
- Barr ME. 1980. On the family *Tubeufiaceae* (Pleosporales). *Mycotaxon* 12: 137–167.
- Batista AC, Peres GEP, Bezerra JL, Cavalcante W de A. 1964. *Hiospira* Moore e outros hyphomycetes do Amazonas. 364–369, in *Anais do XIII Congresso da Sociedade Botânica do Brasil de 1962*. Sociedade Botânica do Brasil.
- Berkeley MJ. 1874. Notices of North American fungi. *Grevillea* 3: 49–64.
- Castañeda-Ruiz RF, Gusmão LFP, Heredia-Abarca G, Saikawa M. 2006. Some hyphomycetes from Brazil. Two new species of *Brachydesmiella*, two new combinations for *Repetophragma*, and new records. *Mycotaxon* 95: 261–270.
- Cavalcanti MS, Milanez AI. 2007. Hyphomycetes isolados da água e do solo da Reserva Florestal de Dois Irmãos, Recife, PE, Brasil. *Acta Bot. Bras.* 21: 857–862.
- CBS 2009. Centraalbureau voor schimmelcultures Filamentous fungi database. Centraalbureau voor Schimmelcultures. Utrecht, The Netherlands [http://www.cbs.knaw.nl/fungi/BioloMICS.aspx (viewed online on April 27, 2009)].
- Chang HS. 2001. *Helicoon doliiformis* sp. nov. and two similar helicosporous hyphomycetes from Taiwan. *Bot. Bull. Acad. Sin.* 42: 149–152.
- Cooper JA. 2005. New Zealand hyphomycete fungi: additional records, new species, and notes on interesting collections. *N. Z. J. Bot.* 43: 323–349.
- Cruz ACR, Gusmão LFP, Castañeda-Ruiz RF. 2007a. Conidial fungi from the semi-arid Caatinga biome of Brazil. *Subramaniomyces pulcher* sp. nov. and notes on *Sporidesmium circinophorum*. *Mycotaxon* 102: 25–32.

- Cruz ACR, Gusmão LFP, Leão-Ferreira SM, Castañeda-Ruiz RF. 2007b. Conidial fungi from the semi-arid Caatinga biome of Brazil. *Diplococcium verruculosum* sp. nov. and *Lobatopedis longistriatum* sp. nov. Mycotaxon 102: 33–38.
- Delgado-Rodríguez G, Mena-Portales J, Caldusch M, Decock C. 2002. Hyphomycetes (Hongos Mitospóricos) del Área Protegida Mil Cumbres, Cuba Occidental. Crypto. Mycol. 23: 277–293.
- Dix NJ, Webster J. 1995. Fungal Ecology. London, Chapman and Hall.
- Farr DF, Rossman AY. 2009. Fungal Databases, Systematic Mycology and Microbiology Laboratory, ARS, USDA. [<http://nt.ars-grin.gov/fungaldatabases/> (viewed online on April 27, 2009)].
- Goos RD. 1980. Some helicosporous fungi from Hawaii. Mycologia 72: 595–610.
- Goos RD. 1985a. On the anamorph genus *Cirrenalia*. Proc. Indian Acad. Sci. (Plant Sci.) 94: 245–252.
- Goos RD. 1985b. A review of the anamorph genus *Helicomycetes*. Mycologia 77: 606–618.
- Goos RD. 1985c. The anamorph genus *Zalerion*. Mycotaxon 23: 445–449.
- Goos RD. 1986. A review of the anamorph genus *Helicoma*. Mycologia 78: 744–761.
- Goos RD. 1987. Fungi with a twist: the helicosporous hyphomycetes. Mycologia 79: 1–22.
- Goos RD. 1989. On the anamorph genera *Helicosporium* and *Drepanospora*. Mycologia 81: 356–374.
- Goos RD. 1990. Review of the anamorph genus *Xenosporium*. Mycologia 82: 742–752.
- Gusmão LFP, Leão-Ferreira SM, Marques MFO, Almeida DAC. 2008. New species and records of *Paliphora* from the Brazilian semi-arid region. Mycologia 100: 306–309.
- Hennings P. 1902. Fungi S. Paulensis II. a cl. Puttemans collecti. Hedwigia 41: 295–311.
- Heredia G, Mercado-Sierra A, Mena-Portales J. 1995. Conidial fungi from leaf litter in a mesophilic cloud forest of Veracruz, Mexico. Mycotaxon 55: 473–490.
- Hughes SJ. 1978. New Zealand fungi 25. Miscellaneous species. N. Z. J. Bot. 16: 311–370.
- Leão-Ferreira SM, Cruz ACR, Castañeda-Ruiz RF, Gusmão LFP. 2008. Conidial fungi from the semi-arid Caatinga biome of Brazil. *Brachysporiellina fecunda* sp. nov. and some new records for Neotropica. Mycotaxon 104: 309–312.
- Linder DH. 1929. A monograph of the Helicosporous Fungi Imperfecti. Ann. Missouri Bot. Gard. 16: 227–388.
- Link HF. 1809. Observations in ordines plantarum naturales. Dissertatio. I. Complectens anadradum ordines epiphytas, Mucedines, Gastromycos et fungos. Ges. Naturf. Freunde Berlin Mag. Neuesten Endec. Gesamnten Naturk. 3: 3–42.
- Matsushima T. 1975. Icones Microfungorum a Matsushima Lectorum. Kobe, Publ. by author.
- Mendes MAS, Silva VL, Dianese JC, Ferreira JASV, Santos CEN, Gomes-Neto E, Urden AF, Castro C. 1998. Fungos em plantas no Brasil. Brasília, EMBRAPA-SPI.
- Mercado-Sierra A. 1982. Taxonomia y aspectos ecológicos de algunos hifomicetes Helicosporicos Hallados en Cuba. Acta Bot. Cubana 11: 1–11.
- Mercado-Sierra A. 1984. Hifomicetes demaciáceos de Sierra del Rosario, Cuba. Havana, Editorial Academica.
- Mercado-Sierra A, Gené J, Figueras MJ, Rodríguez K, Guarro J. 1998. New or rare hyphomycetes from Cuba. IX. Some species from Pinar del Río Province. Mycotaxon 68: 417–426.
- Mercado-Sierra A, Gené J, Guarro J. 1997. Some Costa Rican Hyphomycetes. II. Mycotaxon 64: 7–15.
- Moore RT. 1953. The North Central *Helicosporae*. Proc. Iowa Acad. Sci. 60: 202–216.
- Moore RT. 1954. Three new species of *Helicosporae*. Mycologia 46: 89–92.
- Moore RT. 1955. Index to the *Helicosporae*. Mycologia 47: 90–103.

- Morgan AP. 1892. North American *Helicosporae*. Jour. Cincinnati Soc. Nat. Hist. 15: 39–52.
- Morris EF. 1978. Belizean hyphomycetes. Mycotaxon 7: 265–274.
- Paulus BC, Kanowski J, Gadek PA, Hyde KD. 2006. Diversity and distribution of saprobic microfungi in leaf litter of an Australian tropical rainforest. Mycol. Res. 110: 1441–1454.
- Pennington RT, Prado DE, Pendry CA. 2000. Neotropical seasonally dry forests and Quaternary vegetation changes. J. Biogeogr. 27: 261–273.
- Pinruan U, Hyde KD, Lumyong S, McKenzie EHC, Jones EBG. 2007. Occurrence of fungi on tissues of the peat swamp palm *Licuala longicalycata*. Fungal Divers. 25: 157–173.
- Prado DE. 2000. Seasonally dry forests of tropical South America: from forgotten ecosystems to a new phytogeographical unity. Edinburgh. J. Bot. 57: 437–461.
- Rao PR, Rao D. 1964. Some *Helicosporae* from Hyderabad. II. Mycopathol. Mycol. Appl. 24: 27–34.
- Révay Á. 1998. Review of the hyphomycetes of Hungary. Stud. Bot. Hung. 27-28: 5–74.
- Romero AI. 1983. Contribución al estudio de los hongos xilófilos de la Argentina. II. Ascomycotina en *Eucalyptus viminalis* (Myrtaceae). Bol. Soc. Argent. Bot. 22: 57–79.
- Romero AI, Pildain MB. 2004. Contribución al estudio de los hongos xilófilos de la Argentina. VII. Ascomycotina en *Eucalyptus viminalis* (Myrtaceae). Bol. Soc. Micol. Madrid 28: 125–134.
- Saccardo PA. 1886. Sylloge Fungorum Omnium Hucusque Cognitorum 4: 1–807.
- Sampaio EVSB. 1995. Overview of the Brazilian Caatinga. 35-58, in SH Bullock, HA Mooney, E Medina (eds.), Seasonally dry forests. Cambridge, Cambridge University Press.
- Samuels GJ, Rossman AY, Müller E. 1978. Life-history studies of Brazilian Ascomycetes. 6. Three species of *Tubeufia* with, respectively, dictyosporous, pycnidial and helicosporous anamorphs. Sydowia 31: 180–192.
- Sivanesan A. 1984. The Bitunicate Ascomycetes and their Anamorphs. Vaduz, Lubrecht & Cramer Ltd.
- Tsui CKM, Berbee ML. 2006. Phylogenetic relationships and convergence of helicosporous fungi inferred from ribosomal DNA sequences. Mol. Phyl. Evol. 39: 587–597.
- Tsui CKM, Goh TK, Hyde KD, Hodgkiss IJ. 2001. New species or records of *Cacumisporium*, *Helicosporium*, *Monotosporella* and *Bahusutrabeeja* on submerged wood in Hong Kong streams. Mycologia 93: 389–397.
- Tsui CKM, Sivichai S, Berbee ML. 2006. Molecular systematics of *Helicoma*, *Helicomycetes* and *Helicosporium* and their teleomorphs inferred from rDNA sequences. Mycologia 98: 94–104.
- Yurchenko EO. 2001. On some wood-inhabiting dematiaceous hyphomycetes with remarkable conidia in Belarus. Mycena 1: 32–54.
- Zhao GZ, Liu XZ, Wu WP. 2007. Helicosporous hyphomycetes from China. Fungal Divers. 26: 313–524.

***Chrysosporium linfenense*: a new *Chrysosporium* species with keratinolytic activity**

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Abstract — *Chrysosporium linfenense*, a new *Chrysosporium* species, was collected from Shanxi, China, described, and illustrated. Differences between *C. linfenense* and related species were analyzed based on the morphological and DNA sequence characters. Diagnostic characters of *C. linfenense* are conidia that are solitary or often in chains of 2–3, mostly ellipsoidal or fusiform, few clavate, and smooth-walled; intercalary conidia are absent. The presence of keratinase also suggests that *C. linfenense* possesses a keratinolytic activity.

Keywords — mitosporic fungi, morphology, molecular analysis, classification

Introduction

Chrysosporium species distributed around the world can produce many useful metabolites, especially keratinase, which can be used widely in the chemical industry and environmental protection, medical, and agricultural fields (Kushwaha 2000, Liang et al. 2007). The strain studied (GZUIFR-H31) was isolated from the rhizosphere soil of *Cedrus deodara*. Based on morphological and ITS1-5.8S-ITS2 rDNA sequence characters, this fungus was identified as a new species of *Chrysosporium*, *C. linfenense*.

Materials and methods

Sample collection and strain isolation

Strain GZUIFR-H31 was collected and isolated from the rhizosphere soil of *Cedrus deodara* in Linfen city, Shanxi Province, China. After a soil sample was mixed vigorously

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TABLE 1 Fungi used in the study with their GenBank accession numbers.

NAMES	GENBANK No.	NAME	GENBANK No.
<i>Amauroascus mutatus</i>	AJ271565	<i>C. merdarium</i>	DQ888721
<i>A. niger</i>	AJ271563	<i>C. minutisporosum</i>	AJ131689
<i>Aphanoascus hispanicus</i>	AJ439438	<i>C. pilosum</i>	AJ390385
<i>Ap. punsolae</i>	AJ439440	<i>C. pseudomerdarium</i>	AJ390386
<i>Ap. terreus</i>	AJ439443	<i>C. queenslandicum</i>	AB219228
<i>Auxarthron alboluteum</i>	AB361630	<i>C. siglerae</i>	AJ131684
<i>Castanedomyces australiensis</i>	AJ131785	<i>C. submersum</i>	AJ131686
<i>Chrysosporium articulatum</i>	AJ007841	<i>C. sulfureum</i>	AJ390387
<i>C. carmichaelii</i>	AJ007842	<i>C. synchronum</i>	AJ390388
<i>C. europae</i>	AJ007843	<i>C. tropicum</i>	AJ131685
<i>C. evolceanui</i>	AJ005368	<i>C. undulatum</i>	AJ007845
<i>C. filiforme</i>	AJ131680	<i>C. vallenarense</i>	AJ390389
<i>C. fluviale</i>	AJ005367	<i>C. vespertilii</i>	AJ007846
<i>C. georgiae</i>	AJ007844	<i>C. zonatum</i>	AB219229
<i>C. indicum</i>	AJ005369	<i>Coccidioides immitis</i>	EF186784
<i>C. keratinophilum</i>	AJ131681	<i>Co. posadasii</i>	EF186786
<i>C. linfenense</i>	FJ392561	<i>Morchella conica</i>	AM269501
<i>C. lobatum</i>	AJ131688	<i>M. elata</i>	EF080996
<i>C. lucknowense</i>	AJ131682	<i>Uncinocarpus orissi</i>	AJ390393
<i>C. mephiticum</i>	AJ131683	<i>U. queenslandicus</i>	AB361646
<i>C. merdarium</i>	AJ390384		

with sterile water in a Erlenmeyer flask, the soil suspension was transferred to plates of Martin’s medium and incubated at 30°C. Then the pure cultures were collected, transferred to PDA’s slants, and stored at 4°C in the Institute of Fungus Resources, Guizhou University.

Strain identification and keratinolytic activity

The strain was transplanted to potato dextrose agar (PDA), incubated at 30°C for 14 days, and identified based on colony characters, conidiogenous structures, and keratinolytic activity (Oorschot 1980) and molecular analysis.

Keratinolytic activity was evaluated by the fungal capacity to degrade human hair on the surface of Czapek agar medium with carbon-free and nitrogen-free sources (Carmichael 1962). Keratinolytic evidence was examined by microscope.

DNA extraction and amplification

Taq enzyme and dNTP were from Shanghai Sangon. The strain GZUIFR-H31 was incubated on PDA and the fresh sporulating cultures were used for DNA extraction according to Tigano-Milani et al. (1995). The extracted DNA was stored at -20°C.

The internal transcribed spacer (ITS) region including the 5.8S rDNA was amplified by polymerase chain reaction (PCR) using the primers ITS5 (5'- GGT GAG AGATTT CTG TGC -3') and ITS4 (5'-TCC TCC GCT TAT TGA TAT GC-3'). After a first denaturation step at 94°C for 5 min, the amplification reaction was performed for 35 cycles with denaturation at 94°C for 40 s, annealing at 49°C for 40 s, and extension at 72°C for 1 min; followed by a final extension step at 72°C for 10 min. PCR products

were purified and sequenced with the above primers by Beijing Sunbiotech Co. Ltd. The sequence of ITS1-5.8S-ITS2 rDNA region of strain GZUIFR-H31 was submitted to GenBank (accession number: FJ392561).

Phylogenetic analysis

Strains listed in TABLE 1 were used in the DNA sequence analysis. Some ITS1-5.8S-ITS2 region nucleotide sequences of representative *Chrysosporium* species were obtained from GenBank. The sequences of *C. linfenense* and related fungi species were aligned using the Clustal X1.83 computer program for multiple sequence alignment and corrected manually. The phylogenetic tree was constructed by neighbor-joining method (NJ) of MEGA version 4.0 (Kumar et al. 2004). Confidence values for individual branches were determined by bootstrap analysis (1000 replications).

Results and discussion

Taxonomy

Chrysosporium linfenense Z.Q. Liang, J.D. Liang & Y.F. Han, sp. nov.

FIG. 1

MYCOBANK MB512863; GENBANK FJ392561

Conidia terminalia et lateralibus ex hypha principali vel ramulis lateralibus oriunda, sessilia vel in brevibus protrusionibus, solitaria vel 2–3 catenata, hyaline vel subhyalina, laevia, ellipsoidea vel fusiformia, 3.2–5.4 × 1.4–2.2 μm, raro clavata, 4.2–6.5 × 1.6–2.5 μm, cum cicatricibus basilaribus 1–2 μm. Conidia intercalaria absentes. Chlamydosporae absentes. Ad 40°C non-crescunt. Species ceratinolytica. Reproductio sexualis non videtur.

HOLOTYPE: GZUXIFR-H31, e solo, Linfen, Provincia Shanxi, VI, 2006; in Guizhou Univ., conservatur.

ETYMOLOGY: referring to the region from which the fungus was isolated.

Colonies incubated on PDA at 30°C reached 72mm diam after 14 days, white to cream, short fluffy to powdery, dense, slightly raised at centre; slightly loose in margin, not well defined, fimbriate; reverse white to light yellow. Hyphae hyaline, smooth- and thin-walled, 0.8–1.5(–2.3) μm wide; Racquet hyphae present, 4.5 μm wide, “racquet” 9 μm wide. Terminal and lateral conidia sessile or on short protrusions or lateral branches of variable length, solitary, often in chains of 2–3 or in cluster of 2, subhyaline, smooth, thin-walled, most ellipsoidal or fusiform, 3.2–5.4 × 1.4–2.2 μm, some clavate, 4.2–6.5 × 1.6–2.5 μm with basal scars measuring 1–2 μm, profusely sporulating. Intercalary conidia absent. Chlamydospores absent.

TELEOMORPH: unknown.

GROWTH TEMPERATURES: minimum 15°C, optimum 30°C, maximum 40°C.

KERATINOLYTIC ACTIVITY: Keratinolytic.

DISTRIBUTION: Shanxi province, China

MATERIAL EXAMINED: The holotype GZUIFR-H31 was isolated from the rhizosphere soil of *Cedrus deodara* (Roxb.) G. Don. The paratypes, GZUIFR-H25, GZDXIFR-H26,

and GZUIFR-H29, were isolated respectively from rhizosphere soils of *Euonymus japonicus* Thunb., *Platanus orientalis* L., and *Chukrasia* sp., all obtained in Linfen city, Shanxi Province, China during June, 2006. All strains above are deposited in the Institute of Fungus Resources, Guizhou University.

COMMENTS: *Chrysosporium linfenense* is characterized by a white colony, racquet hyphae, and conidia borne on slightly swollen conidiogenous cells. *C. indicum* (H.S. Randhawa & R.S. Sandhu) Garg 1966 and *C. minutisporosum* P. Vidal & Guarro 2002 also have racquet hyphae and swollen conidiogenous cells, but *C. indicum* often has obovoid to ellipsoid or cymbiform conidia with slightly echinulate walls, and *C. minutisporosum* conidia have verrucose walls and are pyriform, subglobose, or clavate. Additionally, both *C. indicum* and *C. minutisporosum* occasionally form intercalary conidia (Oorschot 1980, Vidal et al. 2002). *Chrysosporium fluviale* P. Vidal & Guarro 2000 is differentiated from *C. linfenense* by obovate, clavate, nearly ellipsoid or pyriform conidia with minute warts and rare intercalary conidia (Vidal et al. 2000) (TABLE 2). Additionally, lateral conidia of *C. linfenense* often form chains of 2–3. *Chrysosporium linfenense* is diagnosed by conidia that are solitary or often in chains of 2–3, mostly ellipsoidal or fusiform (a few clavate), and smooth-walled and by a lack of intercalary conidia.

TABLE 2 A comparison of morphological characters in *C. linfenense* and its related species.

NAMES	SHAPE	CONIDIAL CHARACTERS		
		SIZE (μm)	WALL	INTERCALARY CONIDIA
<i>C. fluviale</i>	Obovate, clavate, nearly ellipsoid or pyriform	(3.5–)4–6.5(–15) × (1–)2–3(–3.5)	Regularly minutely warty	Very rare
<i>C. indicum</i>	Obovoid to ellipsoid, often cymbiform	3.5–7.5 × 1.5–3	Smooth to sl. echinulate	Infrequent
<i>C. linfenense</i>	Most ellipsoidal or fusiform, also clavate	3.2–5.4 × 1.4–2.2	Smooth	Absent
<i>C. minutisporosum</i>	Pyriform or subglobose, also clavate	3–4(–11) × (1.5–)2–2.5(–3.5)	Verrucose	Very rare

Molecular identification

A BLAST search in GenBank was performed using the *C. linfenense* ITS sequence as the query. Close matches showing maximal sequence identities of 80–97% included *Chrysosporium* spp. and other related species. The ITS sequences of these species were retrieved from GenBank for phylogenetic analysis. Relationships of *C. linfenense* and related species were showed in the phylogenetic tree based on analysis of rDNA ITS1-5.8S-ITS2 sequences (FIG. 2). *Morchella conica* Pers. 1818 and *Morchella elata* Fr. 1822 were designated outgroups.

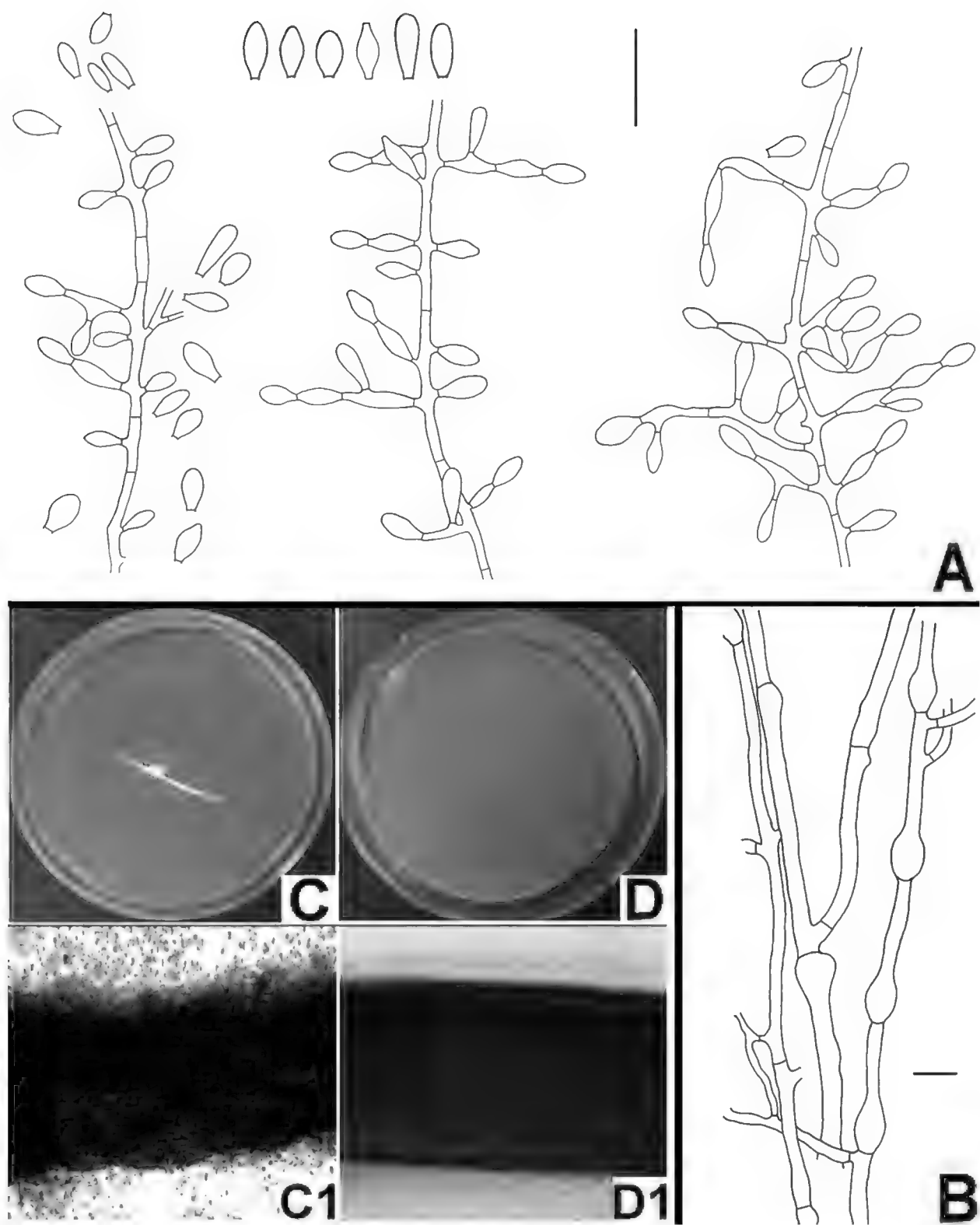


FIG. 1 *Chrysosporium linfenense*. A. Conidiogenous structures and mature conidia B. Racquet hyphae C. A growth of *C. linfenense* along hair on Czapek agar medium with carbon-free and nitrogen-free sources D. A hair on Czapek agar medium with carbon-free and nitrogen-free sources without inoculation C1. The hair degraded by *C. linfenense* after 14d($\times 400$) D1. The hair without being degraded ($\times 400$)(Bars=10 μ m).

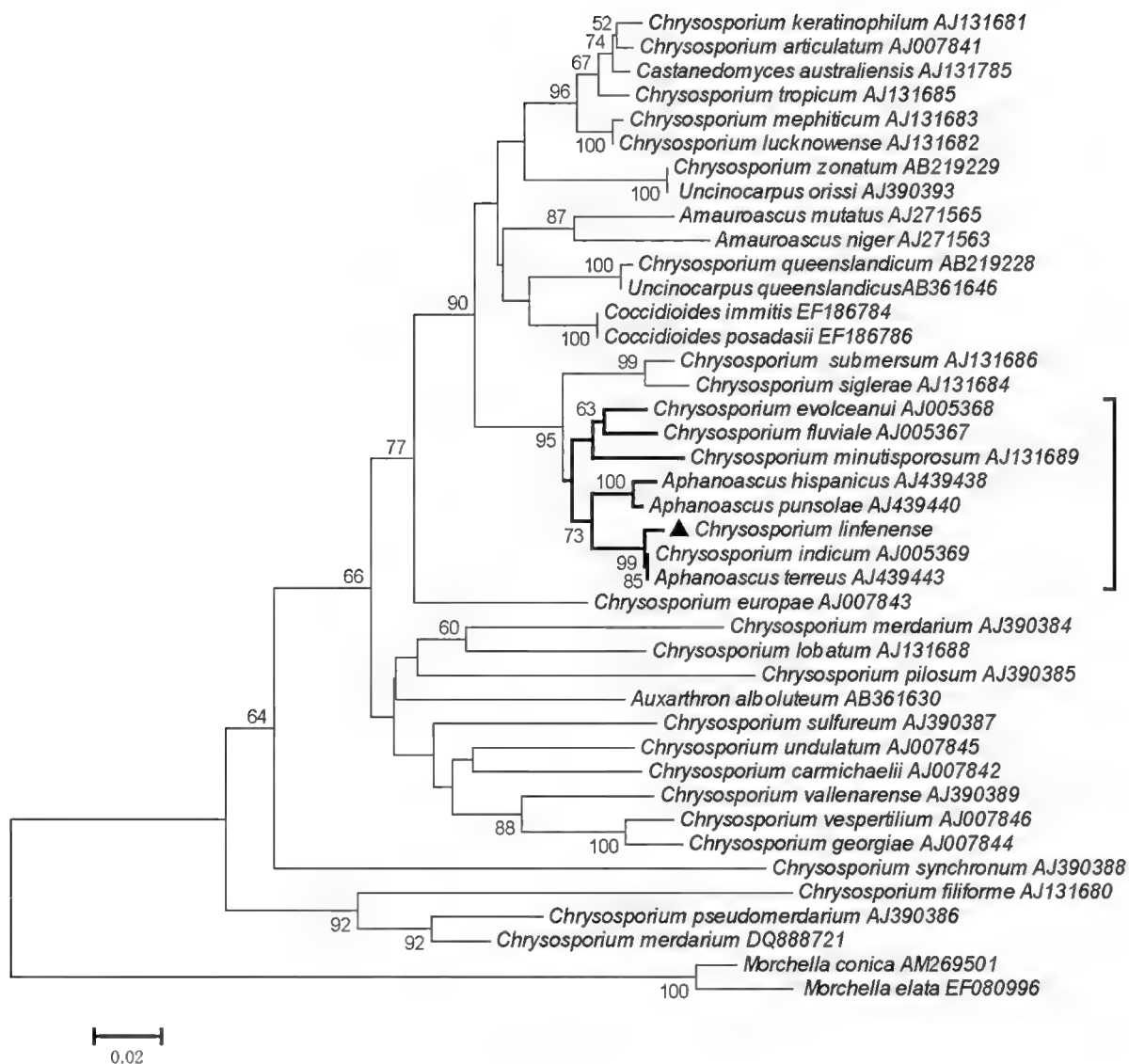


FIG. 2 Phylogenetic tree based on analysis of ITS1-5.8 S rDNA -ITS2 sequences of *C. linfenense* and some related species.

From the phylogenetic tree, *Chrysosporium linfenense*, *C. evolceanui* (H.S. Randhawa & R.S. Sandhu) Garg 1966 (= *C. pannicola* (Corda) Oorschot & Stalpers; Oorschot 1980), *C. fluviale*, *C. indicum*, *C. minutisporosum*, *Aphanoascus hispanicus* Cano & Guarro 1990, *A. punsolae* Cano & Guarro 1990, and *A. terreus* (H.S. Randhawa & R.S. Sandhu) Apinis 1968 were grouped in a subclade. In this clade, *C. evolceanui*, *C. fluviale*, and *C. minutisporosum* differed from *C. linfenense* in their morphological characters (see TABLE 2).

Five other related species were supported (73%) on the adjacent subclade with two branches. One branch (100% support) included *Aphanoascus hispanicus* and *Ap. punsolae*; the second branch (99 % support) included *C. linfenense*, *Aphanoascus terreus*, and *C. indicum*, suggesting a close phylogenetic relationship. As early as 1968, Apinis A.E. reported that *C. indicum* is an anamorph of *Aphanoascus terreus*.

Although *C. linfenense* and *C. indicum* were grouped on the same branch, their genetic separation was also supported (FIG. 2). The morphological

differences between *C. linfenense* and *C. indicum* are likewise marked (see Table 2). Thus, both morphological and molecular analyses support strain GZUIFR-H31 as a new member of *Chrysosporium*.

Keratinolytic activity

Human hair was inoculated by *C. linfenense* on Czapek agar medium with carbon-free and nitrogen-free sources, which was incubated at 30°C for 14d. The *C. linfenense* hyphae grew densely along the hair, which was obviously degraded after 14 days (Fig. 1, C–C1). This keratin degradation shows that *Chrysosporium linfenense* GZUIFR-H31 is a potential keratinase-producing strain.

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Reference

- Apinis AE. 1968. Relationships of certain keratinophilic *Plectascales*. *Mycopathologia et Mycologia Applicata* 35(2): 97–104.
- Carmichael JW. 1962. *Chrysosporium* and some other aleuriosporic hyphomycetes. *Canadian Journal of Botany* 40: 1137–1173.
- Kumar S, Tamura K, Nei M. 2004. MEGA3: Integrated software for Molecular Evolutionary Genetics Analysis and sequence alignment. *Briefings in Bioinformatics* 5: 150–163.
- Kushwaha RKS. 2000. The genus *Chrysosporium*, its physiology and biotechnological potential. In: RKS Kushwaha, J Guarro (Eds). *Biology of dermatophytes and other keratinophilic fungi*. *Revista Iberoamericana de Micología*: Bilbao. pp. 66–76.
- Liang JD, Han YF, Liang ZQ. 2007. A study and application progresses in a group of keratinophilic fungi, the genus *Chrysosporium*. *Journal of Fungal Research* 5(2): 113–118
- Oorschot CAN van. 1980. A revision of *Chrysosporium* and allied genera. *Studies in Mycology* 20: 1–89.
- Tigano-Milani MS, Samson RA, Martins I, Sobral BWS. 1995. DNA markers for differentiating isolates of *Paecilomyces lilacinus*. *Microbiology* 141: 239–245.
- Vidal P, Sanchez-Puelles JM, Milan D, Guarro J. 2000. *Chrysosporium fluviale*, a new keratinophilic species from river sediments. *Mycol. Res.* 104 (2): 244–250.
- Vidal P, Valmaseda M, Vinuesa MÁ, Guarro J. 2002. Two new species of *Chrysosporium*. *Studies in Mycology* 47: 199–209.

Notes on gasteroid fungi of the Brazilian Amazon rainforest

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Abstract — Studies of gasteroid fungi have been limited in Brazil, where the group is poorly known. Although the Brazilian Amazon rainforest is an area of high biodiversity, very few gasteromycetes have been reported for the ecosystem. As a result of recent fieldwork in the state of Rondônia (Brazil's North Region) where gasteroid fungal specimens were collected, a new species was identified that is described here as *Cyathus amazonicus*. *Phallus indusiatus* and *Geastrum fimbriatum* are also newly recorded from the Brazilian Amazon rainforest.

Key words — gasteromycetes, bird's nest fungi, mycodiversity, Neotropics

Introduction

The Gasteromycetes represent a polyphyletic class, as confirmed by the recent molecular studies of Hibbett et al. (1997), Krüger et al. (2001), and Moncalvo et al. (2002). The term 'gasteromycete' is now generally applied informally to describe taxa having a gasteroid habit.

Lodge et al. (1995) consider the Amazon Basin an area of high fungal diversity (Lodge et al. 1995), yet studies on macrofungi of the Brazilian Amazon are few. Although gasteroid fungi often have conspicuous fruiting structures than occasionally are quite bizarre in form, only a handful of studies have focused on the gasteromycetes of Brazil (Baseia & Milanez 2001).

Two species of gasteroid fungi were recorded from the state of Amazonia by Berkeley & Cooke (1876): *Cyathus limbatus* Tul. & C. Tul., and *Scleroderma stellatum* Berk. Hennings (1904) later recorded eight species from the same state: *C. montagnei* Tul. & C. Tul., *Geastrum englerianum* Henn., *G. juruense* Henn., *G. saccatum* Fr., *G. scleroderma* Mont., *Lycoperdon epixylon* Berk. & M.A. Curtis, *L. juruense* Henn., and *Sclerangium brasiliense* Henn.

Capelari & Maziero (1988) reported four gasteroid species from the Amazon rainforest in the state of Rondônia, which they identified as: *Cyathus* sp., *Lycoperdon* sp., *Morganella* sp. and *Morganella fuliginea* (Berk. & M.A. Curtis) Kreisel & Dring.

The state of Rondônia, situated in northwestern Brazil, covers a 237,576 km² area, with nearly 20% of the area designated as conservation units (FIERO 2003). The capital city, Porto Velho (08° 45' 48" S, 63° 54' 48" W), is located on the border between Rondônia and the state of Amazonas on the eastern shore of the Madeira River, a main tributary of the Amazon River. This city contains two important conservation units, the Municipal Natural Park of Porto Velho and the Cuniã Ecological Station. The Municipal Natural Park of Porto Velho, with a total area of 390.8 ha, was created in 1989 to preserve an open ombrophilous forest fragment, mostly in its native state with ~20% secondary or pioneer vegetation. The Cuniã Ecological Station, which covers a 53,221 ha area, was created in 2001. There the two main vegetation types are a open ombrophilous forest and a transition forest with savanna. The station boasts excellent forest conservation and protects the only natural lake and varzea (floodplain forest) complex on the Rio Madeira in Rondônia.

This paper adds to the general knowledge of gasteroid fungi from the Amazon rainforest in providing three new gasteromycete records from Rondônia, including a description of a new species, *Cyathus amazonicus*.

Materials and methods

All research collections were made during the rainy season in the Municipal Natural Park of Porto Velho and the Cuniã Ecological Station, in Porto Velho, Rondônia. Macroscopic examinations followed the usual techniques set forth for gastromycete taxonomic study; microscopical determinations follow Miller & Miller (1988). Specimens were identified using specialized literature (Brodie 1975, Sunhede 1989, Soto & Wright 2000, Calonge 2005, Baseia et al. 2006). Vouchers are deposited in URM (Holmgren & Holmgren 1998).

Taxonomy

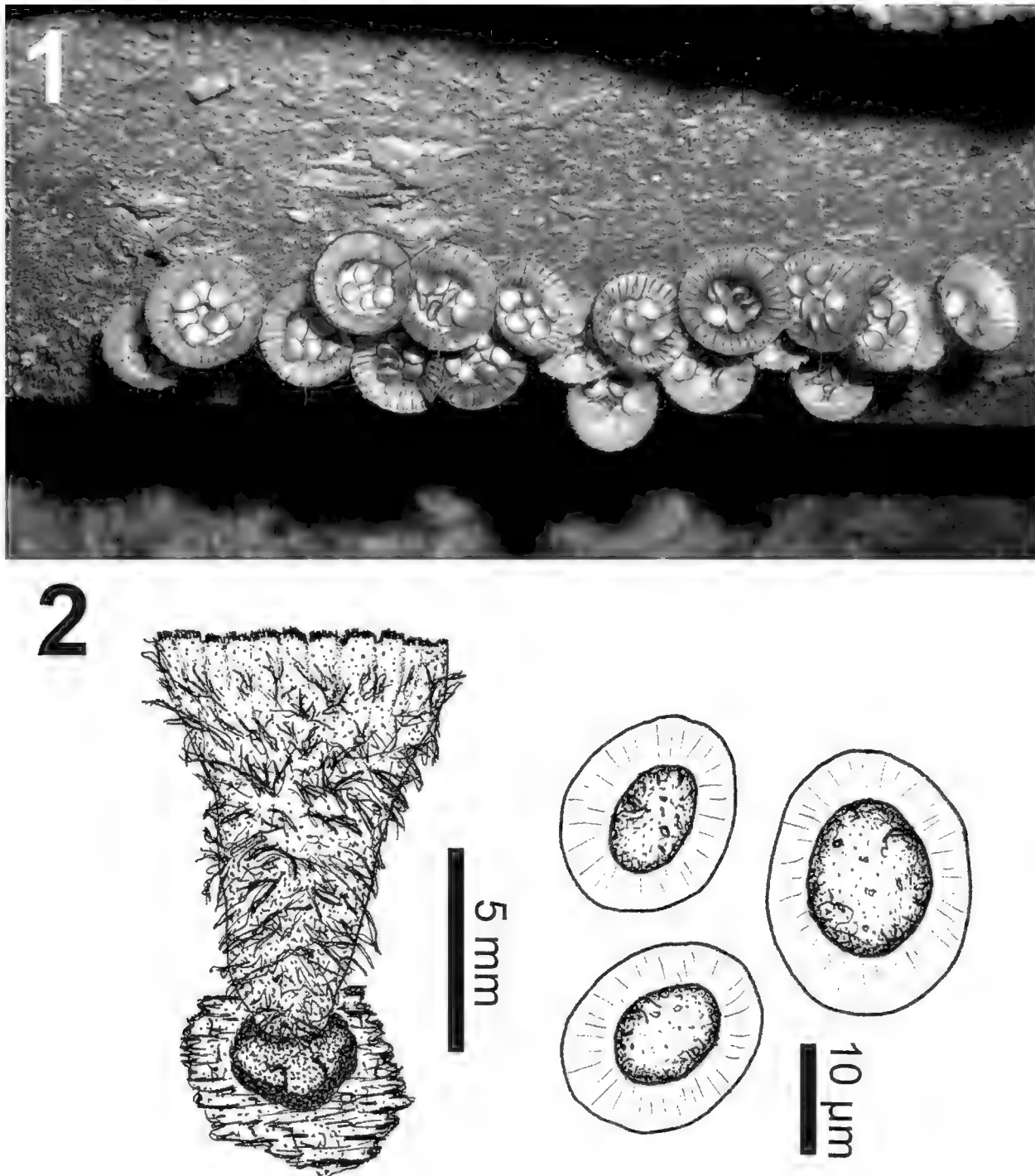
Cyathus amazonicus Trierveiler-Pereira & Baseia, sp. nov.

FIGURES 1–2

MYCOBANK MB 513133

Peridium obconicum veil late obconicum, ad orem 9–11 mm altum, 5–7 mm latum; extus leviter plicatum, brunneum; intus plicatum, griseum veil brunneum; labium minute fimbriatum; peridiola 2–3 × 1.7–2 mm, lentiformia, cortex simplex, tunica subhyalina; sporae subglobosae vel late ellipsoideae, levibus, pariete crasso, 14–19 × 12–16 µm.

HOLOTYPE — Brasília, Rondônia, Porto Velho, Estação Ecológica de Cuniã, ad lignum emortuum in silvis, leg. Gomes-Silva, 429. 15.II.2008 (URM 80036).



FIGURES 1-2. *Cyathus amazonicus*. 1. Basidiomata in situ (scale bar= 1 cm).
2. Basidiome in lateral view and basidiospores.

PERIDIUM obconical to broad obconical, without stalk, 9–11 mm in height and 5–7 mm wide at the mouth, with a distinct reddish brown basal emplacement. EXOPERIDIUM finely plicate in the uppermost portions, very dark brown to grayish dark brown, hirsute; hairs yellowish brown, up to 1.5 mm long; mouth fimbriate. ENDOPERIDIUM distinctly plicate, gray to brownish gray, smooth, shiny. PERIDIOLES lentil-shaped, $2\text{--}3 \times 1.7\text{--}2$ mm, dark gray, shiny, 13–22 peridioles per basidiome; cortex composed of a single layer of hyphae, tunic thin, sub-colourless; funicular cord fibrous, yellowish white to bright yellow.

BASIDIOSPORES subglobose to broadly ellipsoid, thick-walled, hyaline, smooth, 14–19 × 12–16 µm.

SUBSTRATE — undetermined decaying hardwood species.

TAXONOMIC REMARKS — *Cyathus amazonicus* is diagnosed by the large, dark, finely plicate peridium, large (~3 mm diam) peridioles, and subglobose to broadly ellipsoid basidiospores. It resembles *C. helenae* H.J. Brodie and *C. lijiangensis* T.X. Zhou & R.L. Zhao in basidiospore size and shape. The peridium morphology and larger peridioles differentiate these two species from *C. amazonicus* (see TABLE 1).

TABLE 1. Comparison of *Cyathus amazonicus* to similar species.

CHARACTER/SPECIES	C. AMAZONICUS	C. HELENAE	C. LIJIANGENSIS
Size of basidiomata (height × diam. mm)	9–11 × 5–7	7 × 5–6	6–9 × 3–6
Exoperidial colour	Very dark brown to grayish dark brown	Pale brown to gray	Gray to black
Exoperidial hairs	Long, conspicuous, sometimes aggregated into long tufts	Aggregated into nodules	Aggregated into narrow tufts
Peridioles (diam. mm)	2–3	2	1.5–2
Basidiospores (µm)	14–19 × 12–16	15–19 × 12–14	(14)15.5–18.5(–21) × 11–15(–16)
Distribution	Amazon rainforest	Canada, U.S.A., México	China
Reference	Present study	Brodie (1970, 1975)	Zhou et al. (2004)

Key to the described *Cyathus* species of Brazil

- 1a. Basidiospores ≤ 9 µm long 2
- 1b. Basidiospores > 9 µm long 3
- 2a. Endoperidium distinctly plicate; basidiospores 6–9 × 4–7 µm. *C. berkeleyanus*
- 2b. Endoperidium not distinctly plicate; basidiospores 5–6 × 4 µm *C. microsporus*
- 3a. Exoperidia distinctly plicate 4
- 3b. Exoperidia not distinctly plicate 7
- 4a. Peridioles with single cortex 5
- 4b. Peridioles with double cortex 10
- 5a. Basidiospores subglobose to broadly ellipsoid *C. amazonicus*
- 5b. Basidiospores ellipsoid 6
- 6a. Peridia externally brown to blackish, internally shining gray *C. montagnei*
- 6b. Peridia externally chestnut brown, internally yellowish brown *C. striatus*
- 7a. Peridial mouth abruptly flared outwards *C. olla*
- 7b. Peridial mouth not flared outwards 8

- 8a. Peridioles shiny black and lacking tunica; exoperidia woolly to shaggy... *C. stercoreus*
 8b. Peridioles shiny gray and with tunica present; exoperidia not woolly or shaggy. . . 9
 9a. Exoperidia light coloured; peridioles with single cortex *C. pallidus*
 9b. Exoperidia dark coloured; peridioles with double cortex *C. triplex*
 10a. Basidiospores very large, 30-40 µm long *C. poeppigii*
 10b. Basidiospores smaller, ≤ 19 µm long *C. limbatus*

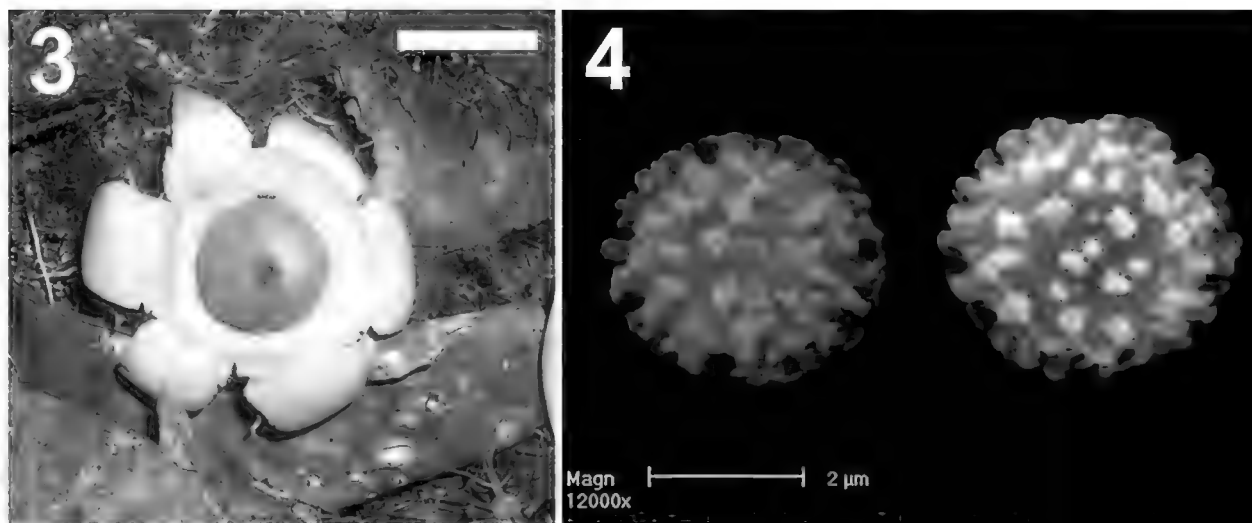
Geastrum fimbriatum Fr., Syst. Mycol. (Lundae) 3(1): 16 (1829). FIGURES 3–4

IMMATURE BASIDIOMATA not observed. EXPANDED BASIDIOME epigeous, 25 mm across and 23 mm high. EXOPERIDIUM non-hygroscopic, saccate, split into 6 rays with acute tips; mycelial layer dirty white, covered with adhering debris. Pseudoparenchymatous layer pinkish white when young, up to 3 mm thick. ENDOPERIDIUM sessile, globose, 13 mm wide and 9 mm high, without apophysis; surface of endoperidium grayish brown to dark brown; peristome fimbrillate, indistinctly delimited, darker than endoperidium; mature gleba very dark brown. BASIDIOSPORES spherical, reddish brown to brown in KOH 3%, 3.5–4.0 µm diam. including the ornamentation, SEM-pictures show ornamentation more or less columnar, rarely confluent. CAPILLITIAL HYPHAE thick-walled, pale brown in KOH, solid or with narrow lumen, 3.5–6.0 µm diam., not branched.

SUBSTRATE — forest soil.

SPECIMEN EXAMINED — BRAZIL. RONDÔNIA: Porto Velho. Estação Ecológica de Cuniã. col. A. C. Gomes-Silva, 428. 15.II.2008 (URM 80037).

TAXONOMIC REMARKS—*G. fimbriatum* resembles *G. saccatum* in morphological characteristics; however, that species has larger basidiospores and the peristome is distinctly delimited by a groove (Baseia et al. 2004). *Geastrum fimbriatum*



FIGURES 3-4. *Geastrum fimbriatum*. 3. Basidiome in situ (scale bar = 2 cm). 4. Basidiospores.

may also be confused with *G. rufescens* Pers., which has smaller basidiospores that differ in ornamentation (Soto & Wright 2000). *Geastrum sessile* (Sowerby) Pouzar, *G. tunicatum* Vittad., and *G. argentinum* Speg. are now considered synonyms of *G. fimbriatum* (Sunhede 1989, Calonge 1998, Kreisel 2001, Soto & Wright 2000). This species has not previously been collected in the North Region of Brazil, having been recorded only in the states of Rio Grande do Sul (Rick 1961), Rio de Janeiro (Berkeley & Cooke 1876), and Pernambuco (Leite et al. 2007, Drechsler-Santos et al. 2008).

Phallus indusiatus Vent., Mém. Inst. Natl. Sci., Sci. Math. 1: 520 (1798).

EGG globose, subglobose to irregular shape, 2.1–3.9 cm in length \times 2.8–4.2 cm in width, pinkish yellow to brownish yellow, rhizoids up to 7.3 cm in length. PSEUDOSTIPE cylindrical to subcylindrical, spongy, appearing white due to the absence of pigments, 4.4–7.3 cm high \times 1.1–1.4 cm in width; indusium well developed, pendulous, yellowish white to dirty yellow, up to 5.0 cm long. PILEUS campanulate, 1.9–3.9 cm high \times 1.5–2.1 cm wide, with yellowish superficial folds that form a network, apex perforated; gleba black, shiny, viscous, foetid. BASIDIOSPORES ellipsoid, straight to slightly curved in side view, thin-walled, hyaline, smooth, 2.0–3.0 \times 1.0–1.5 μ m.

SUBSTRATE — forest soil.

SPECIMENS EXAMINED — BRAZIL. RONDÔNIA: Porto Velho. Parque Natural Municipal de Porto Velho. col. A. C. Gomes-Silva, 357. 21.I.2008 (URM 78881). Same locality. col. A. C. Gomes-Silva, 358. 21.I.2008 (URM 78883). Estação Ecológica de Cuniã. col. A. C. Gomes-Silva, 430. 15.II.2008 (URM 78882). Parque Natural Municipal de Porto Velho. col. A. C. Gomes-Silva, 643. I.2009 (URM 80066).

TAXONOMIC REMARKS — This species is easily recognized in the field owing to the presence of a well-developed veil and white pseudostipe (Baseia et al. 2006). *Phallus indusiatus* has been previously reported from the Brazilian states of Rio Grande do Sul (Rick 1961), Santa Catarina (Möller 1895), Paraná (de Meijer 2006), São Paulo (Viégas 1945, Bononi et al. 1981, Bononi 1984), and Rio Grande do Norte (Baseia et al. 2006). This is the first record from the Brazilian Amazon rainforest.

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Literature cited

- Baseia IG, Maia LC, Calonge FD. 2006. Notes on *Phallales* in the Neotropics. *Bol Soc Micol Madrid* 30: 87–93.
- Baseia IG, Cavalcanti MA, Milanez AI. 2004. Additions to our knowledge of the genus *Geastrum* (*Phallales: Geastraceae*) in Brazil. *Mycotaxon* 85: 409–416.
- Baseia IG, Milanez AI. 2001. *Crucibulum laeve* (Huds.) Kambly in cerrado vegetation of São Paulo, Brazil. *Acta Bot Bras* 15(1): 13–16.
- Berkeley MJ, Cooke MC. 1876. The fungi of Brazil, including those collected by J.W.H. Trail, Esq. M.A. in 1874. *J Linn Soc, Bot* 15: 363–398.
- Bononi VLR. 1984. Basidiomicetos da Reserva Biológica de Mogi Guaçu. *Rickia* 11: 1–25.
- Bononi VLR, Trufen SFB, Grandi RAP. 1981. Fungos macroscópicos do Parque Estadual das Fontes do Ipiranga depositados no Herbário do instituto de Botânica. *Rickia* 9: 37–53.
- Brodie HJ. 1970. A previously unnamed species of *Cyathus* from the Cypress Hills, Alberta. *Can J Bot* 48: 749–750.
- Brodie HJ. 1975. *The Bird's Nest Fungi*. University of Toronto Press, Toronto.
- Calonge FD. 1998. *Gasteromycetes* I. *Lycoperdales*, *Nidulariales*, *Phallales*, *Sclerodermatales*, *Tulostomatales*. *Fl Mycol Ibérica* 3: 1–271.
- Calonge FD. 2005. A tentative key to identify the species of *Phallus*. *Bol Soc Micol Madrid*. 29: 9–18.
- Capelari M, Maziero R. 1988. Fungos macroscópicos do estado de Rondônia. Região dos Rios Jaru e Ji-Paraná. *Hoehnea* 15: 28–36.
- de Meijer AAR. 2006. Preliminary list of the macromycetes from the Brazilian State of Paraná. *Bol Mus Bot Munic* 68: 1–55.
- Drechsler-Santos ER, Wartchow F, Baseia IG, Gibertoni TB, Cavalcanti MAQ. 2008. Revision of the Herbarium URM I. *Agaricomycetes* from the semi-arid region of Brazil. *Mycotaxon* 104: 9–18.
- FIERO; SEBRAE/RO. 2003. Rondônia: perfil socioeconômico industrial. Porto Velho.
- Hennings P. 1904. Fungi amazonici a. cl. Ernesto Ule collecti: 1. *Hedwigia* 43: 154–186.
- Hibbett DS, Pine EM, Langer G, Donoghue MG. 1997. Evolution of gilled mushrooms and puffballs inferred from ribosomal DNA sequences. *Proc Natl Acad Sci, USA* 94: 12002–12006.
- Holmgren PK, Holmgren NH. 1998 [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <<http://sweetgum.nybg.org/ih/>>.
- Kreisel H. 2001. Checklist of the gasteral secotiid *Basidiomycetes* of Europe, Africa and the Middle East. *Österr Z Pilzk* 10: 213–313.
- Krüger D, Binder M, Fischer M, Reisel HK. 2001. The *Lycoperdales*. A molecular approach to the systematic of some gasteroid mushrooms. *Mycologia* 93(6): 947–957.
- Leite AG, Calonge FD, Baseia IG. 2007. Additional studies on *Geastrum* from Northeastern Brazil. *Mycotaxon* 101: 103–111.
- Lodge DJ, Chapela I, Samuels G, Uecker FA, Desjardin D, Horak E, Miller OK, Hennebert GL, Decock CA, Ammirati J, Burdsall HH, Kirk PM, Minter DW, Halling R, Læssøe T, Mueller G, Huhndorf S, Oberwinkler F, Pegler DN, Spooner B, Petersen RH, Rogers JD, Ryvarden L, Watling R, Turnbull E, Whalley AJS. 1995. A survey of patterns of diversity in non-lichenized fungi. *Mitteilungen aus dem Eidgenössische Forschungsanstalt für Wald-, Schnee-, und Landwirtschaft* 70: 157–173.
- Miller Jr. OK, Miller HH. 1988. *Gasteromycetes: morphology and developmental features*. Mad River Press, Eureka.

- Möller FAGJ. 1895. Protobasidiomyceten (Untersuchungen aus Brasilien). Bot Mitt Tropen 8: 1–179.
- Moncalvo JM, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin JW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Cléménçon H, Miller Jr. OK. 2002. One hundred and seventeen clades of euagarics. Mol Phyl Evol 23: 357–400.
- Rick J. 1961. *Basidiomycetes* Eubasidii no Rio Grande do Sul. Brasília. Iheringia 9: 451–480.
- Soto MK, Wright JE. 2000. Taxonomia del género *Geastrum* (*Basidiomycetes*, *Lycoperdales*) en la provincia de Buenos Aires, Argentina. Bol Soc Argent Bot 34(3–4): 185–201.
- Sunhede S. 1989. *Geastraceae* (*Basidiomycotina*). Morphology, ecology and systematics with special emphasis on the North European species. (Synopsis Fungorum 1). Fungiflora, Oslo.
- Viégas AP. 1945. Alguns fungos do Brasil, 10: Gasteromicetos. Bragantia 5(9): 583–595.
- Zhou TX, Zhao LZ, Zhao RL, Chen YI. 2004. Bird's nest fungi from China. Fungal Diversity 17: 243–251.

AFLP characterization in pathogenic and coprophilous fungi

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Abstract — The objective of this study was to ascertain the usefulness of the AFLP technique in assessing genetic diversity among 47 strains belonging to three *Ascomycota* genera and as a tool for solving taxonomic problems in related morphological species. Four MseI +1 primers were assayed in combination with two EcoRI +2 and four EcoRI +3 primers. In the present study both +2 and +3 EcoRI primers were informative, but EcoRI +2 produced profiles with high complexity. The addition of the extra selective nucleotide reduced the complexity of the banding patterns generating easily readable patterns to evaluate genetic diversity within and among species. Of the three ascomycetous genera assessed in this study, *Colletotrichum* (*Glomerellaceae*) presented the highest proportion of polymorphic AFLP loci, followed in order by *Iodophanus* (*Pezizaceae*) and *Saccobolus* (*Ascobolaceae*).

Key words — ascomycetes, genetic characterization, molecular markers, taxonomy

Introduction

Morphological and biochemical characterization of microscopic fungi have usually led to uncertainties in identification when dealing with closely related species or nearly clonal fungal isolates (van Brummelen 1967, Kimbrough et al. 1969, Ramos et al. 2000, Cinto et al. 2007, among others). Molecular markers constitute the current choice to evaluate genetic diversity and to obtain diagnostic characters as an aid for species level identification. For instance, the Amplified Fragment Length Polymorphism method (AFLP, Vos et al. 1995)

is a DNA-based fingerprinting technique frequently used in a diverse array of organisms owing to the generation of high resolution markers, its relative technical simplicity, and because it requires no prior sequence information on the organism under scrutiny (Briad et al. 2002, Gottlieb et al. 2005, Roa et al. 1997, Zeller et al. 2000).

In the present study, we applied AFLP methodology to several filamentous fungal species representing ecologically diverse *Ascomycota* genera in order to investigate the efficiency of these molecular markers to assess genetic diversity and as a tool for solving taxonomic problems in closely related morphological species. The ascomycetes employed here involved the morphospecies *Colletotrichum truncatum* (Schwein) Andrus & W. Moore 1935, *Iodophanus carneus* (Pers.) Korf 1967, *I. testaceus* (Moug.) Korf 1967, *Saccobolus verrucisporus* Brumm. 1967 and *S. versicolor* (P. Karst) P. Karst. 1885. During sexual reproduction these fungi develop haploid spores within an ascus and ascospores that generate a haploid mycelia after germination. In addition, these three genera are found on different substrates. *Iodophanus* and *Saccobolus* are mostly obligate coprophilous fungi. Within these genera, species delimitation is cumbersome due to extensive overlapping in morphological, cytological and developmental features. In contrast, *Colletotrichum truncatum* is the most common pathogen associated with soybean anthracnose (Armstrong-Cho & Banniza 2006). Although more than 50% of cultivated surface in Argentina is designated for soybean production, the genetic variability of this crucial pathogen has not been explored previously.

Material and methods

Fungal strains

Isolation and maintenance of haploid mycelia (monosporic derived strains) of *Iodophanus* and *Saccobolus* species followed procedures set forth by Gamundí & Ranalli (1964). For this purpose, production of mature sexual spore-bearing structures (apothecia) was induced by placing cow and horse dung from different geographical locations into moist chambers (humid filter paper in Petri dishes).

Isolates of the asexual pathogen *Colletotrichum truncatum* were obtained from stem and pod lesions in symptomatic soybean plants (*Glycine max* (L.) Merr.) from different geographical locations, using the procedure of Levin et al. (2007).

The selected fungal strains are deposited at the Herbarium and Culture Collection of the Departamento de Biodiversidad, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (BAFC). TABLE 1 indicates the geographic origin of each strain.

DNA extraction

Actively growing mycelia obtained according to Ramos et al. (2000) were ground in liquid nitrogen. Genomic DNA was extracted following Gottlieb & Lichtwardt (2001). Quality control and quantification of genomic DNA was carried out by agarose gel (0.8%

TABLE 1. List of Argentine fungal strains employed in this survey, their geographical location and BAFC number.

SPECIES	LOCALITY	STRAINS TESTED #
<i>C. truncatum</i>	Gadeken, SF, Arg.	C1 (3093)
<i>C. truncatum</i>	Cerro Azul, SF, Arg.	C2 (3094)
<i>C. truncatum</i>	Armstrong, SF, Arg.	C4 (3096), C5 (3097), C6 (3098)
<i>C. truncatum</i>	Lobos, CH, Arg.	C8 (3100), C9 (3101), C10 (3102)
<i>C. truncatum</i>	Salto, BA, Arg.	C14 (3396)
<i>C. truncatum</i>	Las Lajitas, SA, Arg.	C15 (3397)
<i>C. truncatum</i>	Piamonte, SF, Arg.	C26 (3398)
<i>C. truncatum</i>	Otamendi, CO, Arg.	C24 (3399)
<i>C. truncatum</i>	Las Varillas, SF, Arg.	C25 (3400)
<i>C. truncatum</i>	Chivilcoy, BA, Arg.	C27 (3401)
<i>I. carneus</i>	Hernández, ER, Arg.	TJ 1 (2970); TJ2 (3016); TJ3 (3017); TJ7 (3018); TJ10 (3019)
<i>I. carneus</i>	Gualeguaychú, ER, Arg.	ER1 (2965), ER2 (2966) ER12 (2967) ER14 (2968), ER15 (2969)
<i>I. carneus</i>	Agronomía, CABA, Arg.	ICA1 (3414), ICA2 (3415), ICA3 (3416), ICA4 (3417), ICA5 (3418)
<i>I. testaceus</i>	Núñez, CABA, Arg.	IT 1 (3025), IT4 (3026), IT7 (3027), IT8 (3028) IT10 (3029)
<i>S. verrucisporus</i>	Gualeguaychú, ER, Arg.	M3 (3402), M8 (3403), M10 (3404), M14 (3405)
<i>S. versicolor</i>	Gualeguaychú, ER, Arg.	M4 (3406), M7 (3407), M11 (3408), M13 (3409)
<i>S. verrucisporus</i>	Gob.Castro, ER, Arg.	M9 (3410), M12 (3411), M18 (3412), M19 (3413)

Numbers in brackets correspond to the BAFC culture number (see Materials and Methods).
ER: Entre Ríos Province; CABA: Ciudad Autónoma de Buenos Aires; SF: Santa Fe Province; CH: Chaco Province; BA: Buenos Aires Province; SA: Salta Province; CO: Córdoba Province; Arg.: Argentina.

w/v) electrophoresis and comparison with a DNA molecular-size standard (Lambda EcoRI/HindIII, Promega Corp.). Gels containing ethidium bromide were photographed under UV light.

AFLP methodology

AFLP analysis was carried out on 250 ng of genomic DNA using the AFLP® Analysis System for Microorganisms Primer Kit (Invitrogen) as described in the instructions manual with minor modifications (Gottlieb et al. 2005). Selected primers were combined as in TABLE 2. PCR amplifications were performed in a TECHNE PROGENE thermal cyclor.

Polyacrylamide gel electrophoresis procedures followed Gottlieb et al. (2005). A 30–330 bp AFLP® DNA Ladder (Invitrogen) size marker was included twice in each electrophoresis run. Thus, the size of AFLP bands scored ranged from 90 to 330 bp. AFLP bands were visualized using the SILVER SEQUENCE™ DNA Sequencing System (Promega). Air-dried gels were digitalized and visually analyzed using Adobe Photoshop™ (Adobe Systems, Mountain View, Ca, USA).

Data analysis

Each AFLP band, regardless of its relative intensity, was considered as a dominant allele at a unique locus. The data were coded as either present (1) or absent (0). In some cases, fragments were scored as missing data because character states could not be interpreted unambiguously. Monomorphic bands (bands present in all individuals of a species) were discriminated within each species and across the entire data set. The percentage of polymorphic loci ($P = \text{number of polymorphic loci} / \text{number of loci analyzed}$) for each primer combination was calculated.

Results and discussion

In this study, a total of 46 ascomycetous fungal isolates were surveyed with the AFLP methodology employing ten selective primer combinations, as shown in TABLE 2. As a result, the number of reliable bands scored varied from 26 to more than 100, depending on the primer pair combination used.

For *Colletotrichum truncatum* eight selective primer combinations were tested, among which three rendered highly complex profiles and were not further analyzed (not shown). The remaining five primer combinations showed high P-values of 81.3–92%. For *Iodophanus carneus* and *I. testaceus*, eight AFLP primer combinations were assayed that rendered P-values of 11– 81%. *Saccobolus verrucisporus* and *S. versicolor* yielded the lowest P-value range, 8.3–13%.

Comparing results for the first three primer pairs of TABLE 2 it was evident that *C. truncatum* exhibited the highest proportion of polymorphic AFLP loci, followed in order by *Iodophanus* species and *Saccobolus* species. Our results are not surprising since *C. truncatum* is a highly virulent pathogen and, as such, natural populations are expected to preserve genetic variation.

In regard to the coprophilous fungi, the *Iodophanus* species generally showed more polymorphic bands than *Saccobolus* species (TABLE 2). This might be associated with the fact that *Iodophanus* species develop more variable sexual structures than those produced by *Saccobolus* (Cinto in prep.). Nevertheless, these differences are intriguing since both genera have homothallic life cycles and share the same kind of particular habitat. One major problem regarding identification of microscopic ascomycetes is that dimensions of morphological characters usually overlap. In addition, among other abiotic factors culture conditions and the quantity and quality of light, , would considerably influence ascocarp, ascospore, and ascus sizes (Cinto et al. 2007).

The range of total bands detected herein for *Colletotrichum* is within the range obtained by previous studies using less restrictive combinations (EcoRI+2 and MseI+1) on *Colletotrichum* from alfalfa (44–66) and *Colletotrichum acutatum* (90–105) (James et al. 2003, O'Neill et al. 1997). Similarly, the range of total bands detected for *Didymella bryoniae* (40–86) and *Ophiosphaerella agrostis*

TABLE 2. Total number of AFLP bands, polymorphic and monomorphic bands detected for each selective primer combination in each fungal group assayed and calculated percentage of polymorphic loci (P%).

PRIMER COMBINATION	FUNGAL GROUP	TOTAL N° OF BANDS	POLYMORPHIC BANDS	MONOMORPHIC BANDS	P%
M+G/E+ACG	C	60	55	5	91.66
	I	38	25	13	65.79
	S	45	6	45	13.33
M+C/E+AAG	C	103	95	8	92.23
	I	59	41	18	69.5
	S	60	5	55	8.33
M+T/E+ACG	C	60	55	5	91.67
	I	26	14	12	53.85
	S	53	6	47	11.32
M+A/E+AC	C	+120	#	#	#
	I	80	9	71	11.25
	S	95	8	87	8.42
M+C/E+AA	C	+120	#	#	#
	I	89	11	78	12.36
	S	79	7	72	8.86
M+A/E+AA	C	+120	#	#	#
	I	*	*	*	*
	S	90	7	83	8.4
M+A/E+ACG	C	70	64	6	91.4
	I	42	29	13	69.05
	S	*	*	*	*
M+C/E+ACC	C	75	67	8	89.3
	I	*	*	*	*
	S	50	5	45	10
M+A/E+AAC	C	*	*	*	*
	I	55	45	10	81.82
	S	*	*	*	*
M+T/E+AAC	C	*	*	*	*
	I	58	35	23	60.34
	S	*	*	*	*

C = *Colletotrichum truncatum*; I = *Iodophanus carneus* and *I. testaceus*; S = *Saccobolus versicolor* and *S. verrucisporus*; # = not readable due to banding pattern complexity; * = not tested; E = *EcoRI*; M = *MseI*.

(40–76) is within the range estimated here for *Iodophanus* and *Saccobolus* (Kothera et al. 2003, Cámara et al. 2000). In contrast, and as mentioned above, our results for the non-pathogenic fungi, *Iodophanus* and *Saccobolus*, disagree with results from other studies. In this way the use of AFLP adaptors with three selective bases not only reduced, as expected, the complexity of the banding

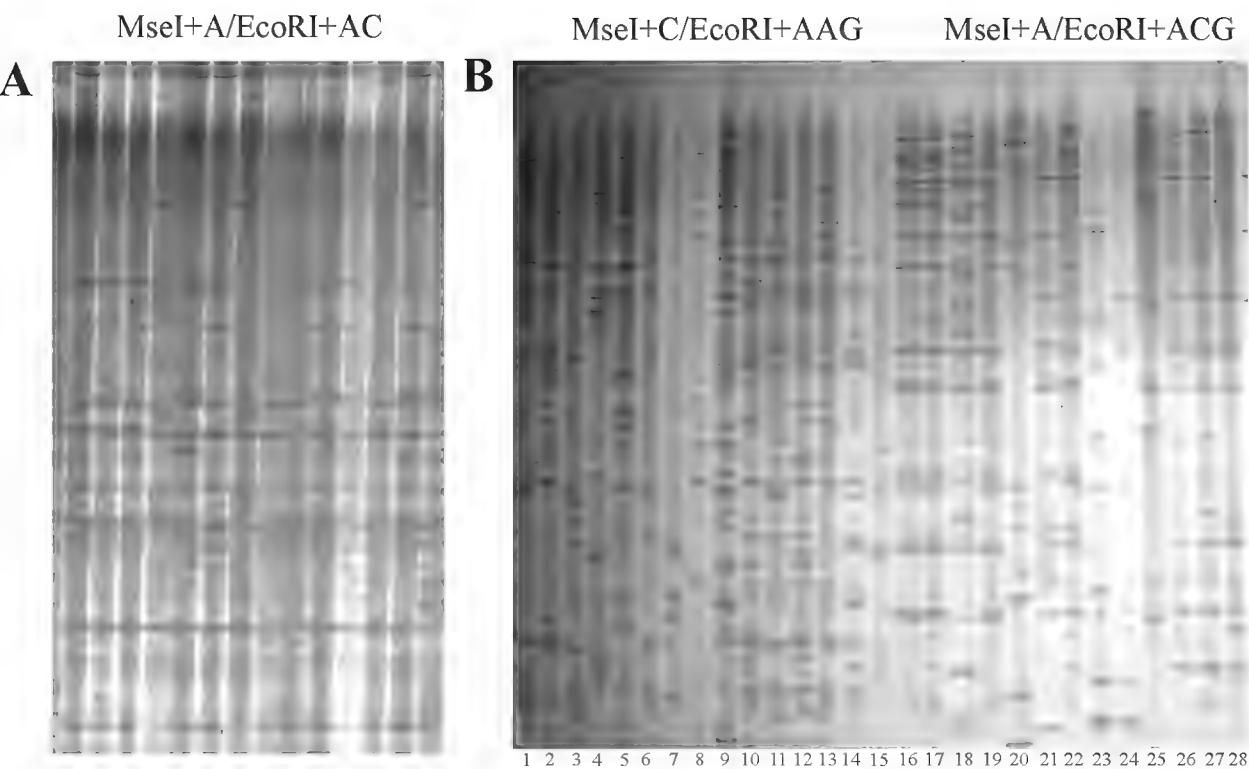


PLATE 1. Section of AFLP showing amplification of DNA. A) *Iodophanus carneus*, M+A/E+AC; B) *Colletotrichum truncatum*, M+C/E+AAG (lanes 1–14) and M+A/E+ACG (lane 15–28)

patterns, it also improved the detection of polymorphic bands (PLATE 1, TABLE 2).

In the present study both +2 and +3 EcoRI primers were informative, but EcoRI +2 produced profiles with high complexity. The addition of the extra selective nucleotide reduced the complexity of the banding patterns generating easily readable patterns to evaluate genetic diversity within and among species. This protocol in which the number of selective nucleotide was tested allows the AFLP procedure to be extended into other *Ascomycota* (fungi) species.

Isolates identified as *S. versicolor* based on morphological characters shared almost 90% of AFLP bands with *S. verrucisporus* in all primer combinations tested. In this way, isolates previously identified as *S. versicolor* could represent an intraspecific variant of *S. verrucisporus*. A higher number of isolates will need to be assessed in order to resolve this relationship.

The present work involved a limited number of ascomycetous species and strains; at this time, more exhaustive studies are being conducted to evaluate the genetic variability of these particular fungi.

Acknowledgments

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Literature cited

- Armstrong-Cho CL, Banniza S. 2006. *Glomerella truncata* sp. nov., the teleomorph of *Colletotrichum truncatum*. Mycol. Res. 110: 951–956.
- Briard M, Le Clerc V, Grzebelus LD, Senalik D, Simon PW. 2000. Modified protocols for rapid carrot genomic DNA extraction and AFLP™ analysis using silver stain or radioisotopes. Pl. Molec. Biol. Rep. 18: 235–241.
- Brummelen J van. 1967. A world-monograph of the genera *Ascobolus* and *Saccobolus* (Ascomycetes, *Pezizales*). Persoonia Suppl. 1: 1–260.
- Cámara MP, O'Neill NR, van Berkum P, Dernoeden PH, Palmer M. 2000. *Ophiosphaerella agrostis* sp. nov. and its relationship to other species of *Ophiosphaerella*. Mycologia 92: 317–325.
- Cinto IE, Dokmetzian DA, Ranalli ME. 2007. *Iodophanus carneus* and *I. testaceus* (Ascomycota, *Pezizales*) Independent taxonomic identity or synonymy? A study of their morphology and isozymes. Bol. Soc. Argent. Bot. 42: 181–187.
- Gamundí IJ, Ranalli ME. 1964. Estudio sistemático y biológico de las Ascoboláceas de Argentina I. Nova Hedwigia 7: 517–533.
- Gottlieb AM, Lichtwardt RW. 2001. Molecular variation within and among species of *Harpellales*. Mycologia 93: 65–80.
- Gottlieb AM, Giberti GC, Poggio L. 2005. Molecular analyses of the genus *Ilex* (Aquifoliaceae) in southern South America, evidence from AFLP and ITS sequence data. Amer. J. Bot. 92: 352–369.
- James CM, Lesemann SS, Down GJ. 2003. Modified AFLP analysis method for species with small genomes. Pl. Molec. Biol. Rep. 21: 303–307.
- Kimbrough JW, Luck-Allen R, Cain RF. 1969. *Iodophanus*, the *Pezizeae* segregate of *Ascophanus* (*Pezizales*). Amer. J. Bot. 56: 1187–1202.
- Kothera RT, Keinath AP, Dean RA, Farnham MW. 2003. AFLP analysis of a worldwide collection of *Didymella bryoniae*. Mycol. Res. 107: 297–304.
- Levin L, Ramos AM, Parisi M, Gally M. 2007. Screening of *Colletotrichum* (Ascomycota) isolates causal agents of soybean anthracnose, for laccase production. Bol. Soc. Argent. Bot. 42: 71–77.
- O'Neill NR, van Berkum P, Lin J, Kuo J, Ude GN, Kenworthy W, Saunders JA. 1997. Application of amplified fragment length polymorphism for genetic characterization of *Colletotrichum* pathogens of alfalfa. Phytopathology 87: 745–750.
- Ramos AM, Forchiassin F, Ranalli ME, Saidman B. 2000. Isozyme analysis of different species of the genus *Saccobolus* (Ascomycetes, *Pezizales*). Mycotaxon 74: 447–462.
- Roa AC, Maya MM, Duque MC, Tohme J, Allem AC, Bonierbale MW. 1997. AFLP analysis of relationships among cassava and other *Manihot* species. Theor. Appl. Genet. 95: 741–750.
- Vos P, Hogers R, Bleeker M, Reijans M, Lee TV, Hornes M, Frijters A, Pot J, Peleman J, Kuiper M, Zabeau M. 1995. AFLP: a new technique for DNA fingerprinting. Nucl. Acids Res. 23: 4407–4414.
- Zeller KA, Jurgenson JE, El-Assiuty EM, Leslie JF. 2000. Isozyme and Amplified Fragment Length Polymorphism from *Cephalosporium maydis* in Egypt. Phytoparasitica 28: 121–130.

New and validated hyphomycete taxa to resolve nomenclatural and taxonomic issues

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Abstract — While completing a compilation and evaluation of all genera of hyphomycetous anamorphs, several confused, invalid, or illegitimate names were encountered that require nomenclatural or taxonomic attention. New genera are proposed to replace the illegitimate names *Arnoldiella* (replaced with *Mycelephas*), *Harziella* (*Lepisticola*), and *Mackenziea* (*Mackenziella*). *Flahaultia* could not be validated because of homonymy and is replaced by *Flahaultiella*, with the new *F. microspora* as its type species. The new genera *Bhatia*, *Cheiroidea*, *Septosporiopsis*, and *Synnemacrodictys*, so far presented only in a PhD thesis, are described for accepted species formerly classified in *Acrodictys* that cannot be classified in existing genera. *Corynesporina* is validated by correcting aspects of its typification. *Goidanichiella*, with its type species represented by a lyophilized culture, is validated here because its protologue did not comply with Art. 37.7. A lectotype species is chosen for *Nematographium*. We comment on several nomenclatural issues for species of *Fusarium*. The typification of *Nectria mariannaeae* is clarified. *Symphyosirella* is proposed for several synnematosous seed parasites formerly included in the inadequately typified genus *Symphyosira*. To avoid destabilization of author citations, we generally have retained the original author citations, although the generic names will be valid and legitimate only from this publication.

Key words — anamorph taxonomy, International Code of Botanical Nomenclature

Introduction

For many years, we have been working on a book-length identification manual for hyphomycete genera to succeed the work by Carmichael et al. (1980). The present paper validates and legitimizes some genus and species names, or

clarifies their typification, in accordance with the rules of the International Code of Botanical Nomenclature (ICBN, McNeill et al. 2006). For the most part, the names are invalid under Art. 36 (no Latin diagnosis), Art. 37 (inadequate typification), or are illegitimate under Art. 53 (later homonym). The introduction of the new Art. 8.4 to the ICBN, which allows metabolically inactive fungal cultures to serve as type, also affects some names discussed here.

In order to avoid destabilization of established author citations, we have validated most taxa in the names of the original authors (with their acknowledged agreement), but the validity and legitimacy of the emended names will date from the present publication. A full author citation will thus include the original authors followed by the bibliographic indication ‘in Gams et al. 2009’.

Seven new genera are introduced for species that are already validly described, but that cannot be adequately classified in existing genera for various reasons. The rationales for these decisions are briefly discussed, but because the species are well described elsewhere, we provide only validating Latin diagnoses and new combinations here. Four of these genera (*Bhatia*, *Cheiroidea*, *Septosporiopsis*, and *Synnemacrodictys*) complete the revision of *Acrodictys* M.B. Ellis sensu lato undertaken by Baker et al. (2001, 2002a, 2002b) in the laboratory of GM-J; full arguments for these genera were presented by Baker (2002).

The genera

ARNOLDIELLA R.F. Castañeda 1984

nom. illegit. Art. 53.1, a homonym of *Arnoldiella* V.V. Mill. 1928 (*Chlorophyta*), to be replaced by:

MYCELEPHAS R.F. Castañeda, **nom. nov.**

MYCOBANK MB 514095

≡ *Arnoldiella* R.F. Castañeda, Revta Jard. Bot. Nac. Habana 5: 58. 1984.

ETYMOLOGY: Greek *mykes* = fungus, *elephas* = elephant, because the conidia suggest an elephant's head when seen from the front.

TYPE SPECIES: *Mycelephas robustus* (R.F. Castañeda) R.F. Castañeda, **comb. nov.**

MYCOBANK MB 514096

FIG. 1

≡ *Arnoldiella robusta* R.F. Castañeda, Revta Jard. Bot. Nac. Habana 5: 60. 1984 (basionym)

Diplorhynchus G. Arnaud (1952), nom. inval. (Art. 36) might apply to the same fungus, but its type (reported as extant by Nicot & Charpentié 1971) must be reexamined to verify this.

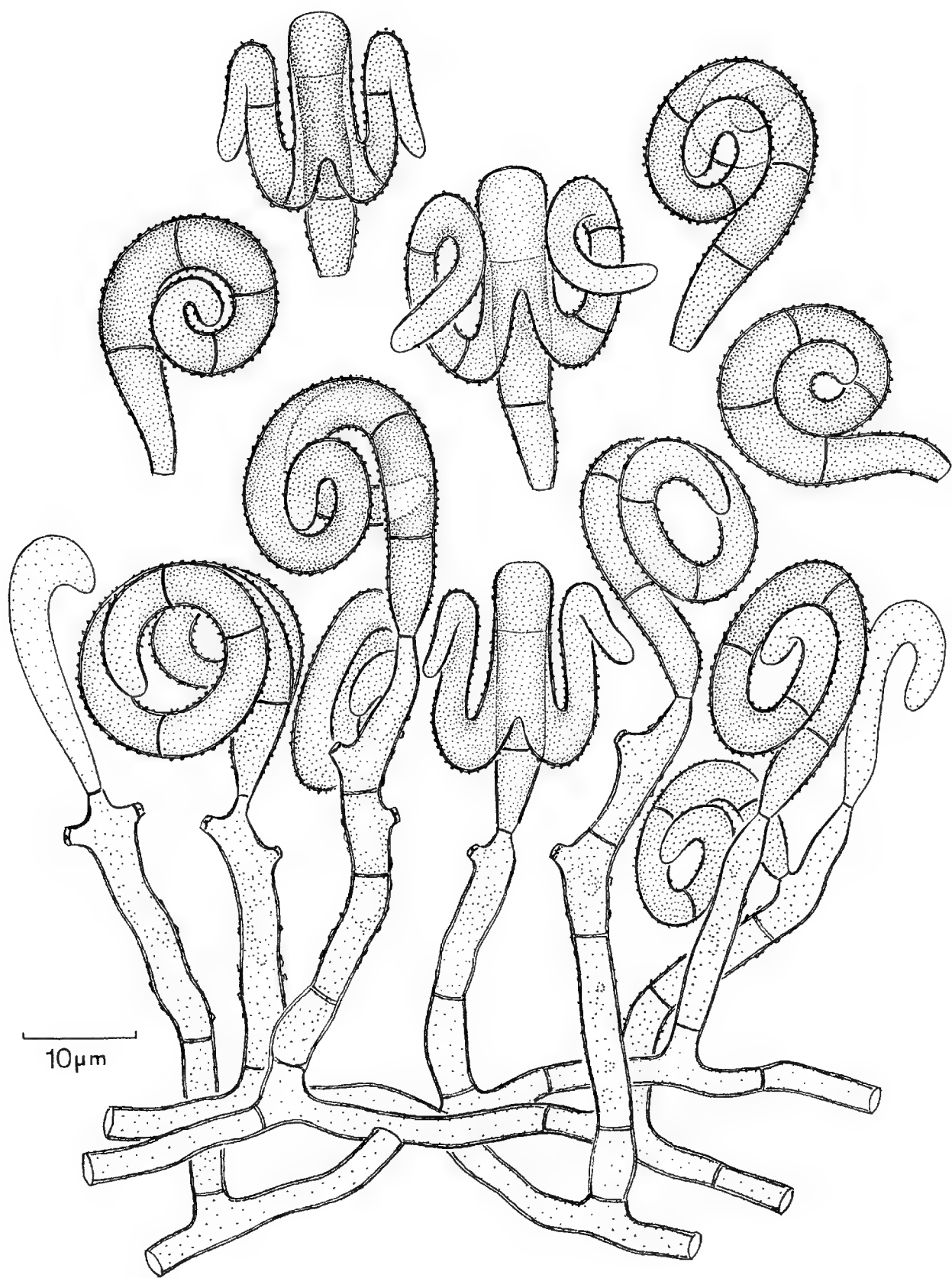


FIG. 1. *Mycelephas robustus*. Line drawings of conidiophores and conidia (after the protologue of *Arnodiella robusta* nom. illegit.).

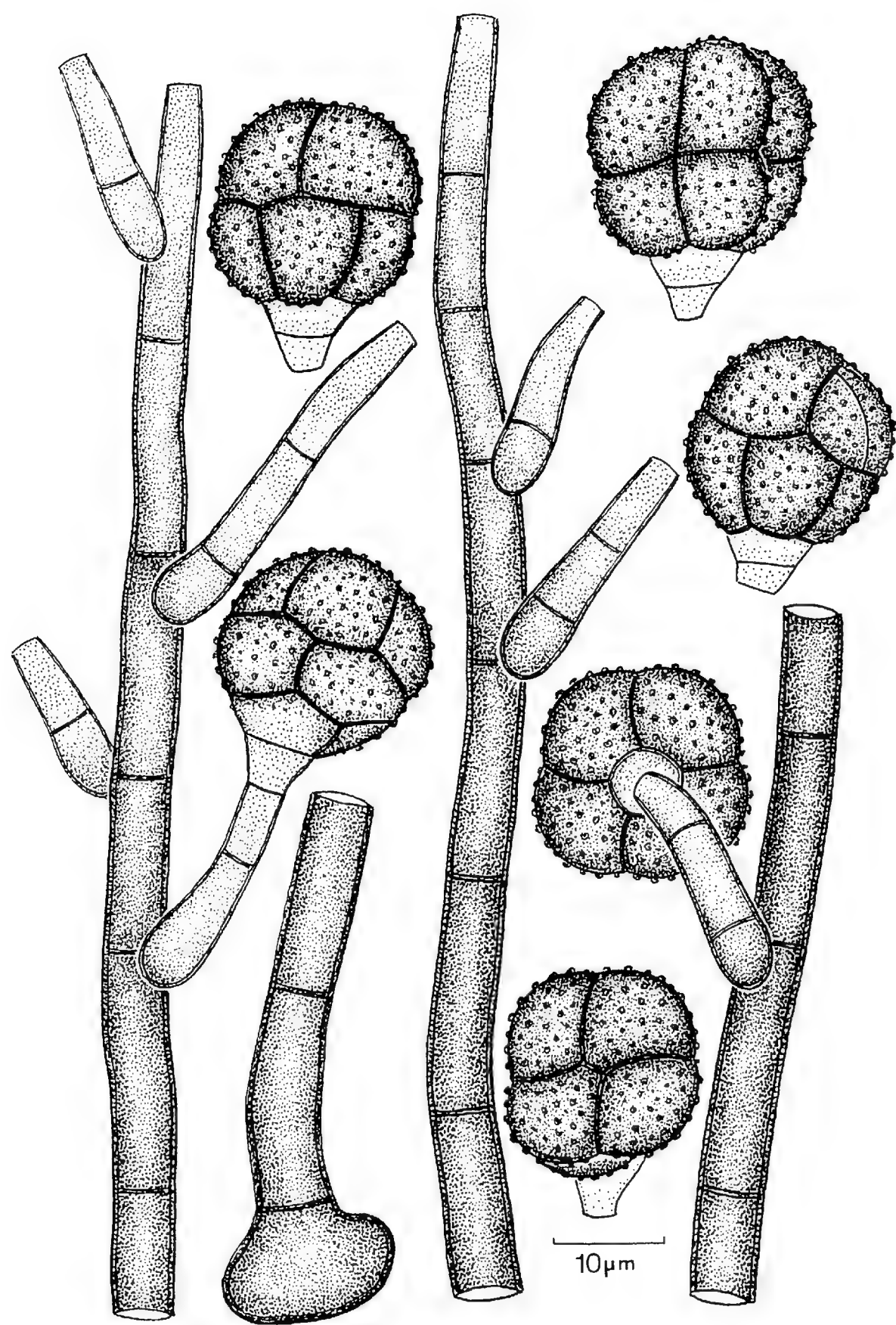


FIG. 2. *Bhatia malabarica*. Line drawings of conidiophores and conidia (redrawn and modified from the protologue).

BHATIA W.A. Baker & Morgan-Jones, **gen. nov.**

MYCOBANK MB 514087

Coloniae effusae, pilosae, atrobrunneae. Mycelium plerumque immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus, cylindricis compositum. Conidiophora macronemata, mononemata, singula, erecta, recta vel leniter flexuosa, laevia, cylindrica, septata, ramosa, brunnea, apicem versus pallidiora, ad basim inflata; rami simplices, attenuati, leniter undulati, septati, pallide brunnei. Cellulae conidiogenae integratae, terminales in axe principali et ramis lateralibus conidiophori, monoblasticae, subhyalinae vel pallide brunneae, determinatae. Conidia holoblastica, solitaria, sicca, acrogena, subglobosa vel turbinata, gangliogena, septis transversalibus, longitudinalibus et obliquis divisa, ad septa constricta, verruculosa, brunnea, cellula basali pallidiore, ad basim truncata, secessio schizolytica.

TYPE SPECIES: **Bhatia malabarica** (Subram. & Bhat) W.A. Baker & Morgan-Jones, **comb. nov.**

FIG. 2

MYCOBANK MB 514089

= *Acrodictys malabarica* Subram. & Bhat, Kavaka 15: 41, 1989 ('1987') (basionym).

ETYMOLOGY: Named in honour of Dr. D. Jayaram Bhat, in recognition of his contributions to our knowledge of hyphomycetes.

The branched conidiophores, strictly monoblastic conidiogenesis (lacking percurrent proliferation), and distinctively ornamented dictyoconidia distinguish *Bhatia* from other genera of the *Acrodictys* complex.

CHEIROIDEA W.A. Baker & Morgan-Jones, **gen. nov.**

MYCOBANK MB 514097

Coloniae effusae, pilosae, atrobrunneae. Mycelium plerumque immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus, cylindricis compositum. Conidiophora macronemata, mononemata, ex hyphis lateralibus oriunda, simplicia, erecta, recta vel leniter flexuosa, laevia, crassitunicata, cylindrica, ad basim inflata, septata, brunnea, interdum apicem versus pallidiora, percurrenter proliferantia. Cellulae conidiogenae in conidiophoris incorporatae, terminales, monoblasticae, pallide brunneae, ad apicem truncatae. Conidia holoblastica, solitaria, sicca, acrogena, digitata, cheiroidea, e cellula basali vel suprabasali communi et ramulis composita; ramuli recti vel curvati, adpressi, septis transversalibus et longitudinalibus divisi; conidia atrobrunnea, cellula basali pallidiore, ad basim truncata, secessio schizolytica.

TYPE SPECIES: **Cheiroidea triarmata** (Whitton, McKenzie & K.D. Hyde) W.A. Baker & Morgan-Jones, **comb. nov.**

FIG. 3

MYCOBANK MB 514099

= *Acrodictys triarmata* Whitton, McKenzie & K.D. Hyde, Fungal Diversity 4: 166. 2000 (basionym, HOLOTYPE HKU(M) 13034!).

ETYMOLOGY: Greek *cheir* = hand, *-oideus* = like.

This genus is proposed primarily in recognition of its peculiar cheiroid conidia, which have three branches, two originating from the basal cell attached to the conidiophores and the third arising from the proximal cell of one of the

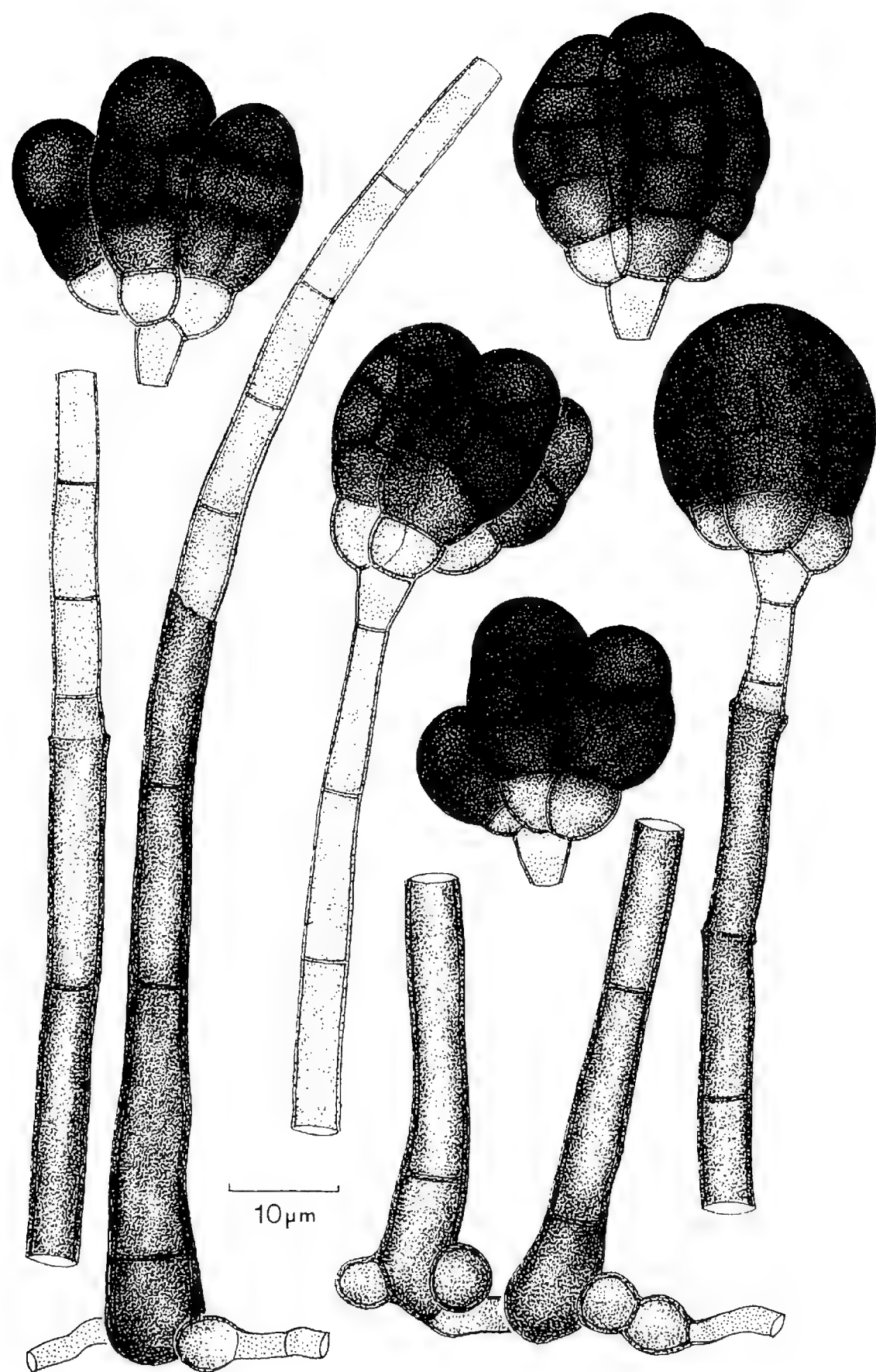


FIG. 3. *Cheiroidea triarmata*. Line drawings of conidiophores and conidia (holotype, HKU(M) 13034).

primary branches. The basal cells of the conidia are paler than the dark brown terminal cells that comprise most of the conidial body.

CORYNESPORINA Subram., gen. nov.

MYCOBANK MB 513877

Corynesporina Subram., Nova Hedwigia 59: 268. 1994. nom. inval. Art. 37.1.

TYPE SPECIES: *Corynesporina elegans* Subram., sp. nov.

MYCOBANK MB 513878

Corynesporina elegans Subram., Nova Hedwigia 59: 268. 1994. nom. inval. Arts 37.1, 43.1.

The Latin diagnoses of the both the species and the genus were published on the page indicated. The missing information on the location of the holotype was obtained from the author, and the genus and species are thus validated here: On dead leaf (in litter) of *Smilax calophylla* Wall. (*Smilacaceae*), McRitchie Reservoir, Singapore, 20 May 1987, coll. C.V. Subramanian (S 141a), Herb. MUBL 3523.

FLAHAULTIA G. Arnaud 1951. nom. inval. Arts 36, 37.

According to Nicot & Charpentié (1971), there is no type specimen for this genus, which is nevertheless recognizable from Arnaud's illustration. The specimens that we have found are consistent with Arnaud's generic concept, but have smaller conidia and shorter conidiophores and thus represent a different species from Arnaud's *F. hyalina*. Despite several attempts, we were unable to culture our fungus, and suspect it is more likely to be a mycoparasite of, rather than the anamorph of, a *Sebacina* sp., as has sometimes been hypothesized (e.g. Watling & Kendrick 1979). Because the name *Flahaultia* is preoccupied by a red alga, we are introducing our fungus with an appropriate holotype as the type of a new genus, *Flahaultiella*.

FLAHAULTIELLA Seifert, gen. nov.

MYCOBANK MB 514100

[*Flahaultia* G. Arnaud, Bull. trimest. Soc. mycol. Fr. 67: 195. 1951, nom. inval. Art. 53, non Bornet 1892 (*Rhodophyta*)]

Conidiophora monoverticillata, hyalina, levia, uno septo prope basim separata, fibulis carentia. Cellulae conidiogenae hyalinae, ad apicem binae vel ternae verticillatae, cylindricae vel subulatae, laterales axim versus valde curvatae, monoblasticae vel semel vel bis sympodialiter proliferantes, conidiis isthmo connexae, post liberationem schizolyticam cicatricem inconspicuam paulo obscuriorem relinquentes. Conidia hyalina, unicellularia, ellipsoidea vel oblonge ellipsoidea, nonnumquam paulo asymmetrica vel curvata, ad basim primum truncata sed deinde rotundata, in massa mucida transparente aggregata.

TYPE SPECIES: *Flahaultiella microspora* Seifert.

Flahaultiella microspora Seifert, sp. nov.

MYCOBANK MB 514101

FIGS. 4, 5

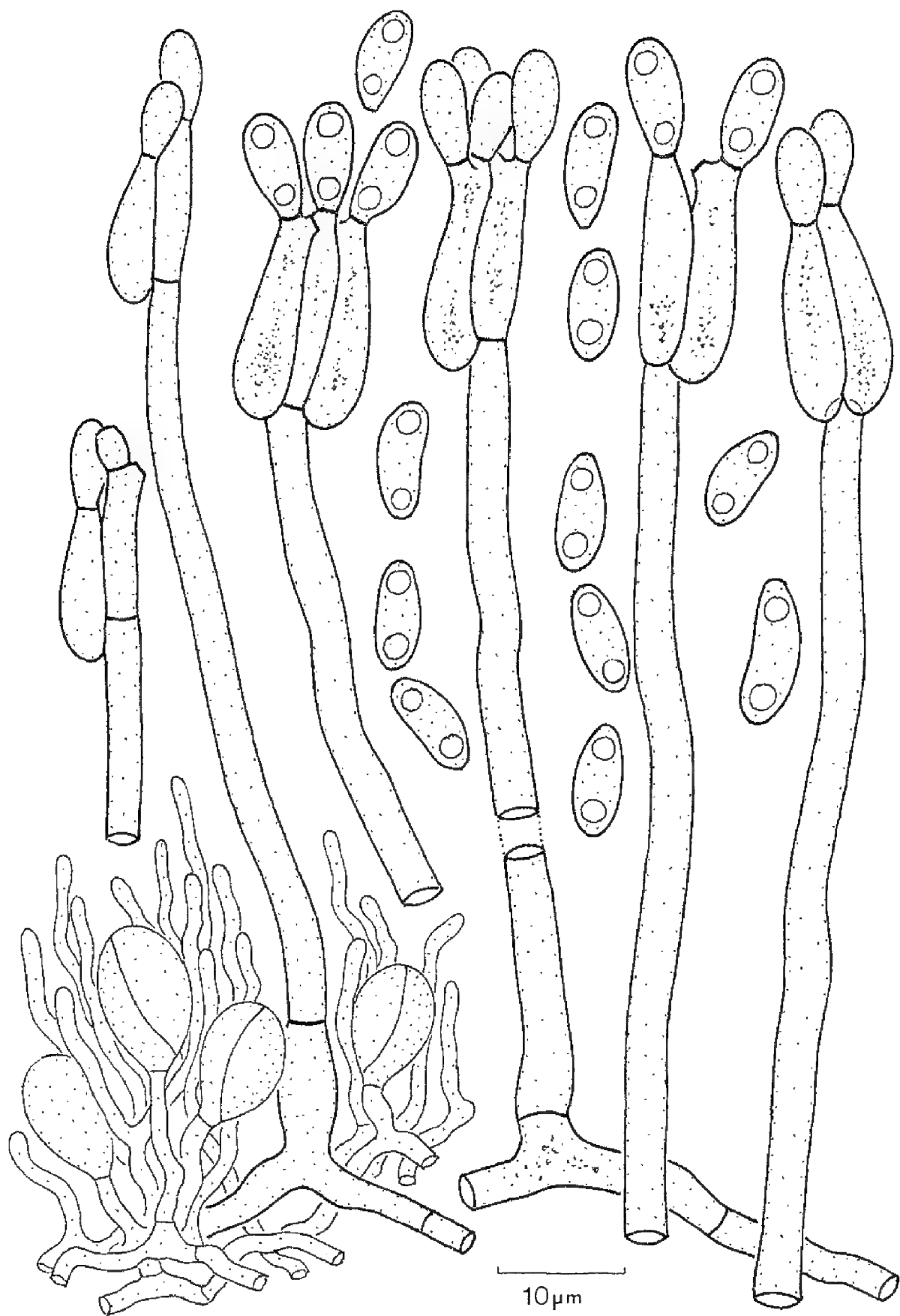


FIG. 5. *Flahaultiella microspora*, Line drawings of conidiophores emerging from tremelloid host, conidia (holotype, DAOM 238641).



FIG. 4. *Flahaultiella microspora*, phase contrast micrographs of conidiophores and conidia (holotype, DAOM 238641).

Conidiophora circa 40–60 μm alta, e 5–7 μm prope basim ad 2.5–4 μm sursum angustata. *Cellulae conidiogae*: una axialis 10–17 \times 3–4.5 μm , 1–2 laterales 12–20.5 \times 3.5–5 μm , *conidiis* isthmo 1.5–3 μm lato connexae. *Conidia* 8–10.5 \times 2–3 μm (in medio $8.5 \pm 0.1 \times 3.5 \pm 0.1 \mu\text{m}$), in massa mucida circa 15–20 μm diam aggregata.

TYPE: on dead wood of *Populus* sp., associated with *Sebacina* sp., Fletcher Wildlife Garden, Ottawa, Canada (N 45°23'12", W 75°42'08"), 13 June 1997, coll. K.A. Seifert (s.n.). Holotype: DAOM 238641.

Colonies effuse, inconspicuous. Conidiophores monoverticillate, about 40–60 μm tall, hyaline, smooth-walled, with a single septum just above the base, the stipes tapering, 5–7 μm wide at the basal septum, 2.5–4 μm wide below the conidiogenous cells; lacking clamp connections; apparently losing its cytoplasm during development. Conidiogenous cells hyaline, occurring in a terminal whorl of (2–)3; one cell continuing the axis of the stipe of the conidiophore, cylindrical or subulate, 10–17 \times 3–4.5 μm ; the other two appressed to the axis, curving abruptly at the base to meet the conidiophore stipe at nearly a right angle, 12–20.5 \times 3.5–5 μm ; monoblastic or extending sympodially for a short distance (< 3 μm) 1–2 times, with a broad connection to the conidia 1.5–3 μm wide, leaving a slightly dark scar and inconspicuous frills after schizolytic secession; apparently losing cytoplasm during conidiogenesis. Conidia hyaline, aseptate, 8–10.5 \times 2–3 μm (mean = $8.5 \pm 0.1 \times 3.5 \pm 0.1 \mu\text{m}$, $n = 25$), ellipsoidal or oblong ellipsoidal, sometimes slightly asymmetrical or slightly curved, base at first truncate but rounded at maturity, accumulating in clear slimy mass about 15–20 μm diam.

We have not seen specimens with conidia that match the dimensions for *Flahaultia hyalina* G. Arnaud, and thus the status of that species will remain uncertain until new specimens are collected.

FUSARIUM Link 1809 : Fr.

A few combinations proposed by Nirenberg (1976) lacked a full basionym citation. Some of these names have become generally accepted and no older competing names have been discovered:

Fusarium proliferatum (Matsush.) Nirenberg, Mitt. Biol. Bundesanst. Ld- u. Forstw. 169: 38. 1976,

was validated as:

Fusarium proliferatum (Matsush.) Nirenberg ex Gerlach & Nirenberg, Mitt. Biol. Bundesanst. Ld- u. Forstw. 209: 309. 1982.

MYCOBANK MB 509381

Fusarium proliferatum var. *minus* Nirenberg 1976

was since renamed

Fusarium phyllophilum Nirenberg & O'Donnell 1998

and need not be validated separately.

Fusarium sacchari var. *subglutinans* (Wollenw. & Reinking) Nirenberg 1976

would require validation at this rank, but this fungus was validly renamed and recognized as

Fusarium subglutinans (Wollenw. & Reinking) Nelson, Toussoun & Marasas (Nelson et al. 1983).

Fusarium acutatum Nirenberg & O'Donnell

MYCOBANK MB 444880

The 1998 publication of this species was considered invalid according to Art. 37.7 (formerly Art. 37.3, Index of Fungi 6: 979, 1999). The authors listed BBA 69580 and some other deposits for the single ex-type culture, a dried culture of which was then deposited in herb. B. We regard this as a sufficient unequivocal characterization of the type material in accordance with Art. 37.7.

GOIDANICHIELLA G.L. Barron ex W. Gams, **gen. nov.**

MYCOBANK MB 513879

Goidanichiella G.L. Barron ex W. Gams, in Gams, Steiman & Seigle-Mur., Mycotaxon 38: 152. 1990, nom. inval. Art. 37.7.

TYPE SPECIES:

Goidanichiella barronii W. Gams, Steiman & Seigle-Murandi, **sp. nov.**

MYCOBANK MB 513880

Goidanichiella barronii W. Gams, Steiman & Seigle-Murandi, Mycotaxon 38: 152. 1990, nom. inval. Arts 37.7, 43.1.

?= *Goidanichiella scopula* (Preuss) G. L. Barron, Gen. Hyphom Soil, 180. 1968, nom. inval. Arts 32.6, 43.1.

Gams et al. (1990) intended to validate this genus, introduced previously by Barron (1968), by providing a Latin diagnosis and describing the new species *Goidanichiella barronii* as its type. The type material of *G. barronii* was indicated as 'CBS 101.89 = CMPG 426', which rendered the name invalid according to Art. 37.7. This designation of a living culture also would have invalidated the novelty according to the then relevant Art. 37.1 (Index of Fungi 6: 76). However, since that publication, Art. 8.4 was added to the ICBN, allowing metabolically inactive fungal cultures to serve as type. At that time, it was already standard practice at CBS to preserve all new accessions as lyophiles and also to dry Petri dish cultures to be maintained in the herbarium (for this fungus, herb. no. 4390, dried Dec. 1989). Because of the retroactivity of Art. 8.4, both the genus and the species would now be acceptable as validly published were it not for the inclusion of the CMPG number. Following the original designation, the lyophile culture of CBS 101.89 must serve as type.

The other species described in the genus are consequently invalid according to Art. 43.1 and require revalidation.

***Goidanichiella sphaerospora* Matsushima, sp. nov.**

MYCOBANK MB 513883

Goidanichiella sphaerospora Matsushima, Icon. Microfungorum Matsush. lect., p. 77, 1975, nom. inval. Art. 43.1.

Latin diagnosis in Icon. Microfungorum Matsush. lect., p. 77, 1975. Typus MFC 2613.

***Goidanichiella fusiformis* K.D. Hyde, Yanna, Pinnoi & E.B.G. Jones, sp. nov.**

MYCOBANK MB 513882

Goidanichiella fusiformis K.D. Hyde, Yanna, Pinnoi & E.B.G. Jones (as '*G. fusiforma*'), Fungal Diversity 11: 119, 2002, nom. inval. Art. 43.1.

Latin diagnosis in Fungal Diversity 11: 119, 2002. Typus HKU(M) 13225.

***Goidanichiella cylindrospora* D.W. Li & G.H. Zhao, sp. nov.**

MYCOBANK MB 513881

Goidanichiella cylindrospora D.W. Li & G.H. Zhao, Mycotaxon 101: 42, 2007, nom. inval. Art. 43.1.

Latin diagnosis in Mycotaxon 101: 42, 2007. 1992. Typus BPI 877773.

Because Art. 8.4 is effective retroactively, it may also affect several species of *Acremonium* published by Gams (1971), and also must be considered in future studies of that genus.

***HARZIELLA* Costantin & Matr. 1899**

nom. illegit. Art. 53.1, a homonym of *Harziella* Kuntze 1891 (hyphomycetes).

Kuntze introduced this generic name originally to replace *Trichocladium* Harz 1871, because of supposed homonymy with *Trichocladus* Pers. 1807 (*Hamamelidaceae*). *Harziella capitata* Costantin & Matr. is a characteristic

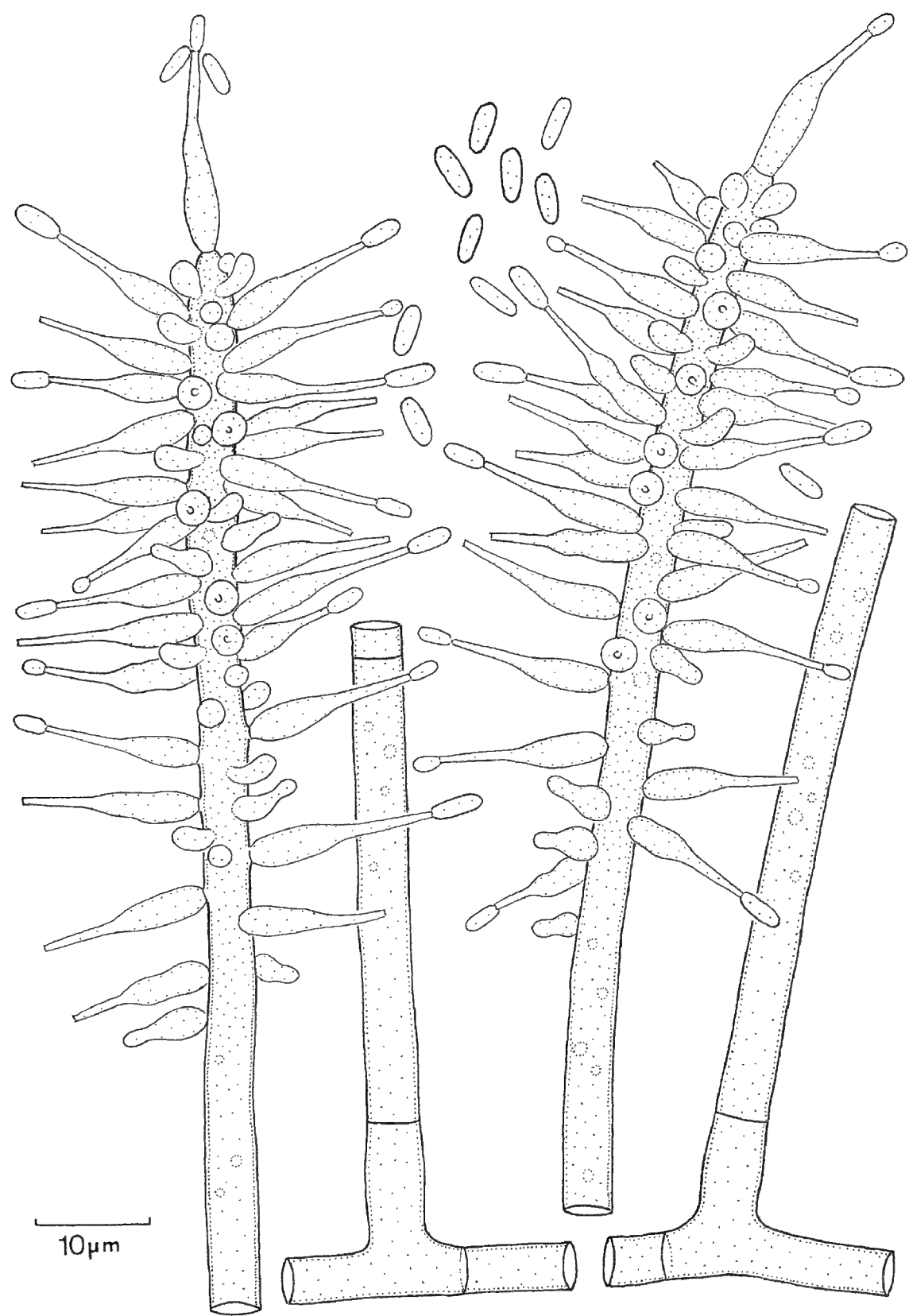


FIG. 6. *Lepisticola capitata*, conidiophores and conidia (DAOM 237837).

hypocrealean, phialidic, hyphomycetous anamorph growing on basidiomata of the agaric *Lepista nuda* (Bull.) Cooke, well illustrated by the original authors but for which no legitimate generic name is available. Other species often referred to *Harziella* Costantin & Matr. [anamorphs of *Melanospora* (Ceratostomataceae)]

and synanamorphs of species of *Harzia* Costantin 1888 and *Olpitrichum* G.F. Atk.] are properly classified in *Proteophiala* Cif. 1957.

LEPISTICOLA W. Gams, **nom. nov.**

MYCOBANK MB 514102

= *Harziella* Costantin & Matr., Bull. Soc. Mycol. Fr. 15: 107, 1899.

TYPE SPECIES: *Lepisticola capitata* (Costantin & Matr.) W. Gams, **comb. nov.** FIG. 6

MYCOBANK MB 514103

= *Harziella capitata* Costantin & Matr., Bull. Soc. Mycol. Fr. 15: 107, 1899 (basionym).

LIVING CULTURES: CBS 182.64, CBS 140.92, DAOM 237837. A dried culture of CBS 182.64, CBSH 20310, is designated here as **NEOTYPE**.

MACKENZIEA Yanna & K.D. Hyde 2002

nom. illegit. Art. 53, a homonym of *Mackenziea* Nees 1847 (*Acanthaceae*).

To be replaced by:

MACKENZIELLA Yanna & K.D. Hyde, **nom. nov.**

MYCOBANK MB 514104

= *Mackenziea* Yanna & K.D. Hyde, Aust. syst. Bot. 15: 757. 2002, nom illegit. Art. 53.1.

TYPE SPECIES: *Mackenziella livistonae* (Yanna & K.D. Hyde) Yanna & K.D. Hyde, **comb. nov.**

MYCOBANK MB 514105

= *Mackenziea livistonae* Yanna & K.D. Hyde, Aust. syst. Bot. 15: 757. 2002 (basionym).

ETYMOLOGY: A diminutive of *Mackenziea*.

MARIANNAEA G. Arnaud ex Samson 1974

The only teleomorph known to be associated with a species of this genus, *Nectria mariannaeae* Samuels & Seifert (1992), is invalid (Art. 37.7); the holotype was indicated as deposited in VEN and NY. The authors' intention was to designate VEN 2980 deposited in VEN as the single holotype specimen and this is stated explicitly here; the specimen in NY is an isotype.

Nectria mariannaeae Samuels & Seifert, **sp. nov.**

MYCOBANK MB 513884

Latin diagnosis in Sydowia 43: 257. 1992. Typus VEN 2980.

This species was not reconsidered in the redistribution of species of *Nectria* (Tode) Fr. sensu lato by Rossman et al. (1999), and it is likely that it will eventually be transferred to another genus.

NEMATOGRAFIUM Goid., Annali Bot. 21: 46, 1935.

MYCOBANK MB 9090

Goidànich (1935) transferred five species from *Graphium* Corda to this new genus. Of these, we could find no type specimens for *Graphium strictum* Preuss (not listed in the Preuss herbarium by Jülich 1974), *G. saccardoi* Peyronel (not in PAD), and *G. stilboideum* Corda (not in PRM). *Graphium leucophaeum* Sacc.

was considered a taxonomic synonym of *Gracilistilbella aterrima* (Welw. & Curr.) Seifert by Seifert (1985, as *Stilbella*). The fifth species, based on *Clavularia hippotrichoides* Lindau, is well typified by a specimen in Lindau's herbarium in B. It is an entomogenous species, congeneric with several others misclassified in *Tilachlidiopsis* Keissl. and *Stilbella* Lindau. This complex will be the subject of a comprehensive revision, but the generic name is fixed by here designating *C. hippotrichoides* as the **lectotype** species of *Nematographium*:

Nematographium hippotrichoides (Lindau) Goid., *Annali Bot. (Roma)* 21: 46. 1935

MYCOBANK MB 230599

= *Clavularia hippotrichoides* Lindau, *Rabenh. Krypt. Fl. Ed. 2, 1(9)* 313. 1910 (basionym) (B!).

= *Graphium hippotrichoides* (Lindau) Sacc., *Syll. Fung.* 22: 1449. 1913.

= *Tilachlidiopsis hippotrichoides* (Lindau) Keissl., *Annln naturh. Mus. Wien* 37: 216. 1924.

SEPTOSPORIOPSIS W.A. Baker & Morgan-Jones, **gen. nov.**

MYCOBANK MB 514106

Coloniae effusae, pilosae velutinae, atrobrunneae vel atrae. Mycelium partim superficiale vel plerumque immersum, ex hyphis ramosis, septatis, pallide brunneis compositum. Conidiophora semi-macronemata, mononemata, singula, ex hyphis lateralibus oriunda, simplicia, erecta vel ascendente, recta vel leniter flexuosa, laevia, crassitunicata, cylindrica, continua vel septata, pallide vel medio brunnea, sursum pallidiora, indeterminata, plerumque percurrenter proliferantia. Cellulae conidiogenae in conidiophoris incorporatae, terminales, monoblasticae, pallide brunneae, anguste cuneatae, apicem versus truncatae. Cellula separans liberatione disrupta. Conidia holoblastica, solitaria, sicca, acrogena, ellipsoidea, septis transversalibus et interdum longitudinalibus divisa, laevia, plerumque cellulis lateralibus protrudentibus praedita, brunnea vel atrobrunnea, cellula superiore et basali pallidioribus, ad basim minute fimbriata, secessio rhexolytica.

TYPE SPECIES: ***Septosporiopsis elaeidis*** (J.M. Yen & Sulmont) W.A. Baker & Morgan-Jones, **comb. nov.**

FIG. 7

MYCOBANK MB 514107

= *Acrodictys elaeidis* J.M. Yen & Sulmont, *Cah. La Maboké* 8: 35. 1970 (basionym).

= *Septosporium elaeidis* (J.M. Yen & Sulmont) Piroz., *Mycol. Pap.* 129: 23. 1972.

= *Acrodictys elaeidis* var. *cubensis* Hol.-Jech., *Česká Mykol.* 37: 12. 1983.

ETYMOLOGY: *Septosporium* + Greek *-opsis* = aspect of.

This species is excluded from *Acrodictys* because of its reduced rather than macronematous conidiophores, and the percurrently extending conidiogenous locus that extends beyond the remains of a separating cell after rhexolytic conidial secession. It differs from the species of *Septosporium* Corda by lacking a phialidic (or pycnidial) element as part of the body of the conidium, and the absence of erect, dark, thick-walled setae.

SYMPHYOSIRA Preuss 1853 ('1852')

The holotype of the type species, *S. lutea* Preuss 1853, has no identifiable fungus (B!) and the protologue lacks sufficient clues to the identity of this

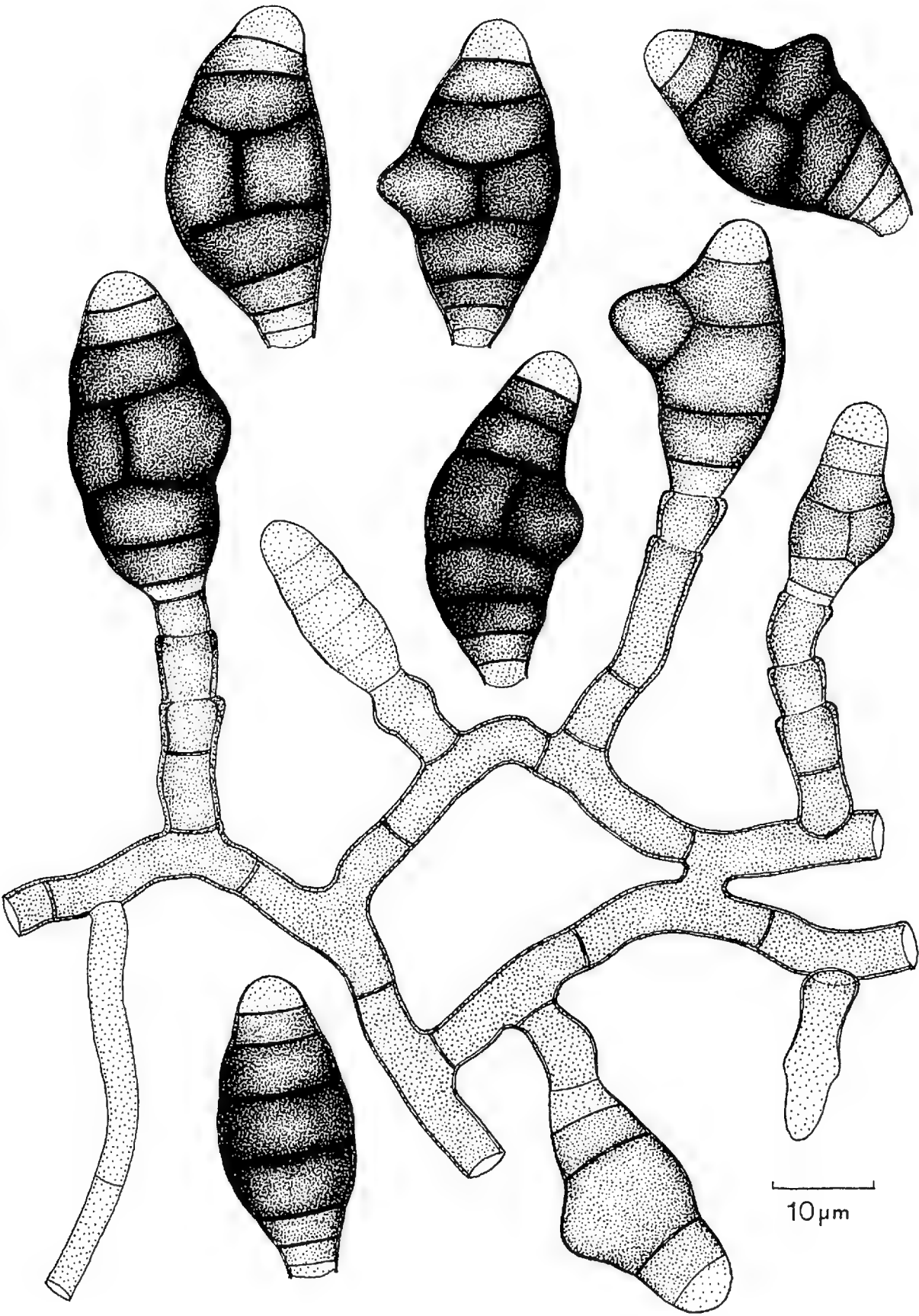


FIG. 7. *Septosporiopsis elaeidis*. Conidiophores and conidia (DAOM 134086).

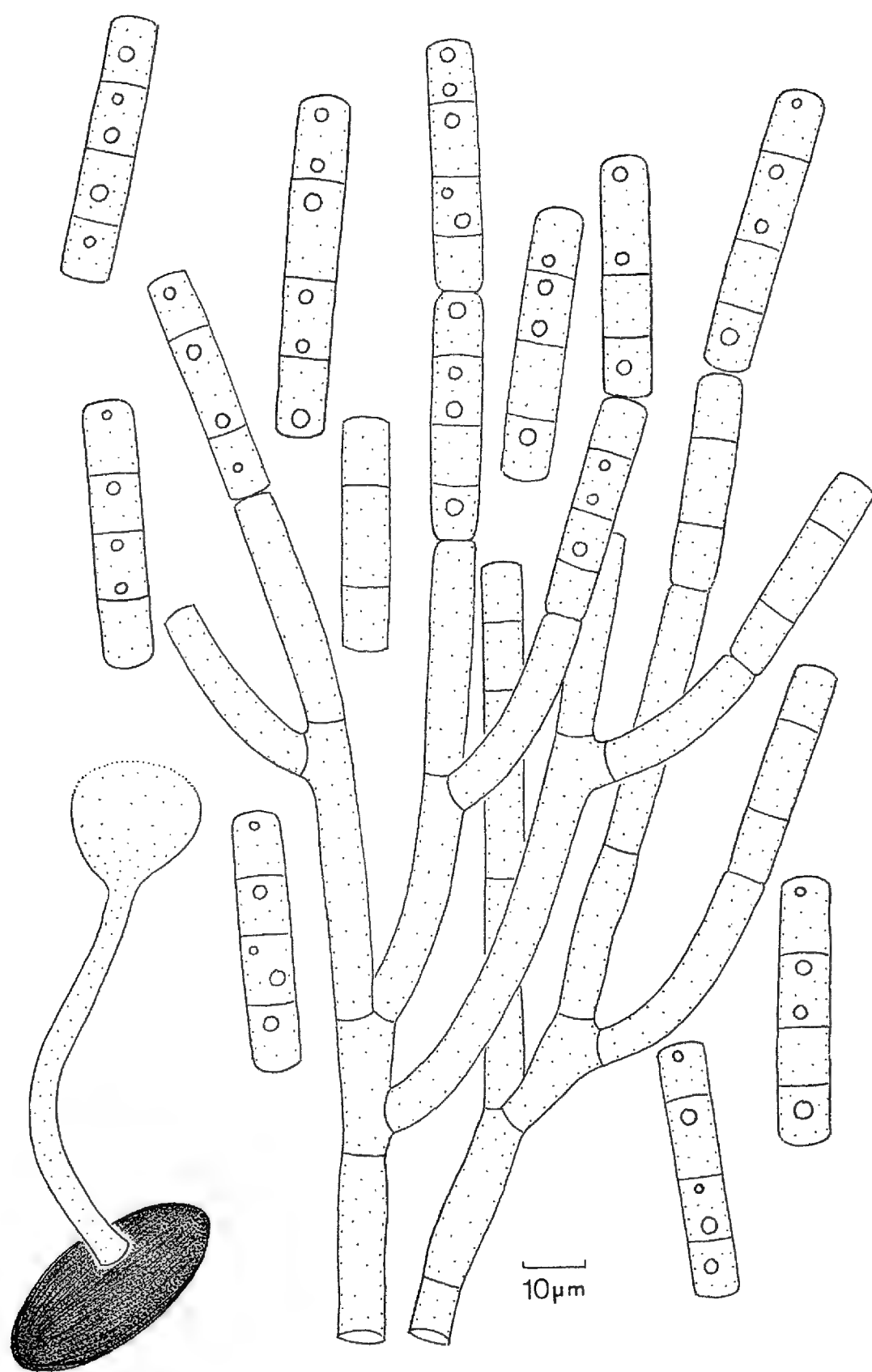


FIG. 8. *Symphyosirella parasitica*. Synnema, conidiophores and conidia (holotype W3317).

species. *Symphyosira parasitica* Masee & Crossl. and *S. rosea* Keissl. are relatively well understood species, apparently obligate parasites of seeds, and are the basis for the prevailing application of *Symphyosira* by Keissler (1913), Ellis (1956) and Baral (1994) for anamorphs of *Symphyosirinia* E.A. Ellis, a concept that excludes the lignicolous *S. lutea*. Rather than proposing conservation of *Symphyosira* with a new type, we describe the new genus *Symphyosirella* for these two species.

SYMPHYOSIRELLA Seifert, gen. nov.

MYCOBANK MB 514108

Conidiomata synnemata, determinata, pallida, apice capitato. Conidiophora nonramosa vel parceramosa, vel monovorticillata, hyalina. Cellulae conidiogenae thallicae-arthricae, hyalinae. Conidia phragmoseptata, hyalina, mucosa, in catenis disposita, secessio schizolytica, conidia juvenia nonnumquam 2-3 setulis apicalibus praedita. Teleomorphosis Symphyosirinia (Helotiales).

ETYMOLOGY: A diminutive of *Symphyosira*.

TYPE SPECIES: *Symphyosirella parasitica* (Masee & Crossl.) Seifert, **comb. nov.**

FIG. 8

MYCOBANK MB 514109

= *Symphyosira parasitica* Masee & Crossl., Naturalist (Jan. 1904): 6. 1904 (basionym, **HOLOTYPE** K!).

Symphyosirella rosea (Keissl.) Seifert, **comb. nov.**

MYCOBANK MB 514110

= *Symphyosira rosea* Keissl., Mykol. Zentbl. 2: 322. 1913 (basionym, **HOLOTYPE** W 3317!).

Neither *S. rosea* nor *S. parasitica* has been conclusively demonstrated to be the anamorph of a known *Symphyosirinia* species, but they are clearly congeneric with the anamorph of *Symphyosirinia* described by Ellis (1956).

Of the remaining three species attributed to *Symphyosira*, we have not recombined the seed pathogen *S. clematidis* Baral (the anamorph of *Symphyosirinia clematidis* Baral, see Baral 1994). It differs from *S. parasitica* and *S. rosea* in details of conidiogenesis, and perhaps morphogenesis of synnemata, characters that require taxonomic re-evaluation. The holotype of the lignicolous species *S. alba* P. Karst. (H) represents a sporodochial fungus with acropetal chains of didymoconidia, and will be treated in a future publication along with similar specimens collected in Canada. *Symphyosira areola* (G.F. Atk.) Sawada is a synonym of *Ramulariopsis gossypii* (Speg.) U. Braun (Braun 1993).

SYNNEMACRODICTYS W.A. Baker & Morgan-Jones, gen. nov.

MYCOBANK MB 514111

Coloniae effusae, pilosae, brunneae vel atro-brunneae. Mycelium immersum, ex hyphis ramosis, septatis, laevibus, brunneis compositum. Synnemata determinata, erecta, simplicia, atro-brunnea vel nigra, apice capitato. Conidiophora macronemata, recta vel leniter flexuosa, ramosa, simplicia, cylindrica, septata, laevia, olivaceo-brunnea

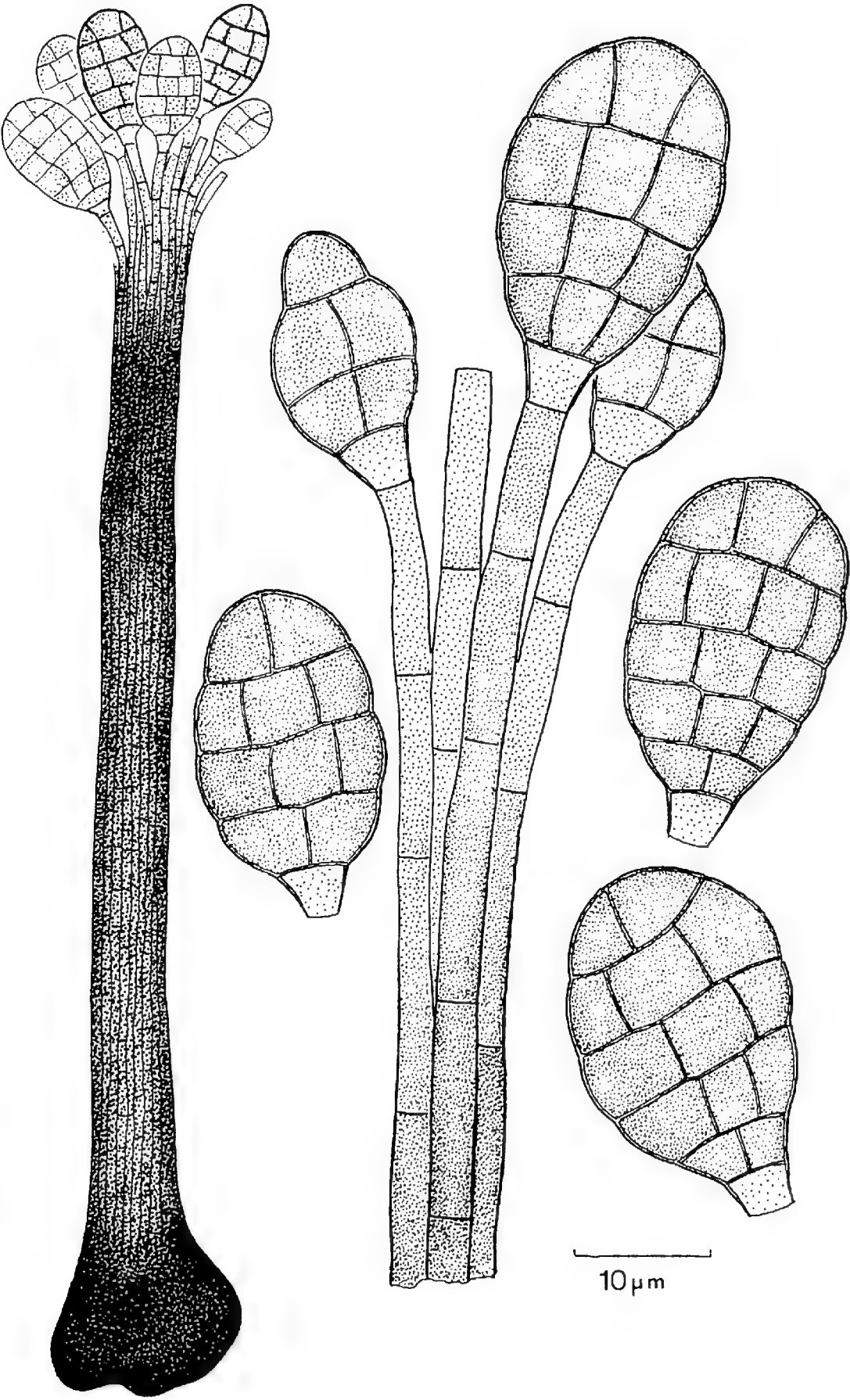


FIG. 9. *Synnemacrodactys stilboidea*. Conidiophores and conidia (redrawn and modified from the protologue).

vel brunnea. Cellulae conidiogenae monoblasticae, in conidiophoris incorporatae, terminales, determinatae, cylindricae. Conidia holoblastica, solitaria, sicca, acrogena, septis transversalibus et longitudinalibus divisa, laevia, ellipsoidea vel turbinata, olivaceo-brunnea, cellula basali pallidiore, truncata, secessio schizolytica.

TYPE SPECIES: *Synnemacrodictys stilboidea* (J. Mena & Mercado) W.A. Baker & Morgan-Jones, **comb. nov.** FIG. 9

MYCOBANK MB 514112

= *Acrodictys stilboidea* J. Mena & Mercado, Acta Bot. Hung. 32: 190. 1986 (basionym, HOLOTYPUS HAC 7040 non vidimus).

ETYMOLOGY: *synnema*, indicating the type of conidiomata + *Acrodictys*.

The synnematous conidiomata, and lack of percurrent proliferation of the conidiogenous cells, exclude this species from inclusion in *Acrodictys*.

Acknowledgments

We are grateful to C.V. Subramanian for clarifying the location of his type specimen; Kevin Hyde for his willingness to describe *Mackenziella* and present the new combination in *Goidanichiella* here; Rafael Castañeda Ruiz for his permission to describe *Mycelephas* here; Helgard I. Nirenberg for her agreement with the *Fusarium* treatment; W.A. Baker for access to the information published in his PhD thesis; and T. Matushima, D.W. Li, and G.H. Zhao for agreeing to validate their species of *Goidanichiella* here. The curators of B, CBS, DAOM, HKU(M), IMI and W kindly loaned specimens from their collections. Kathie Hodge shared the culture that served as the basis for FIG. 6. Scott Redhead, Paul M. Kirk, Shaun Pennycook, and Toni Atkinson provided many constructive suggestions as pre-reviewers.

Literature cited

- Arnaud G. 1952. Mycologie concrète. Bull. Trimestriel Soc. Mycol. France 68: 181–223.
- Baker WA. 2002. Taxonomic studies in the genus *Acrodictys* sensu lato (Hyphomycetes). PhD thesis, Auburn University, Alabama.
- Baker WA, Partridge EC, Morgan-Jones G. 2001. Notes on Hyphomycetes. LXXXI. *Acrodictyella obovata*, a new lignicolous, dematiaceous genus and species collected in Alabama. Mycotaxon 78: 29–35.
- Baker WA, Partridge EC, Morgan-Jones G. 2002a. Notes on Hyphomycetes. LXXXV. *Junewangia*, a genus in which to classify four *Acrodictys* species and a new taxon. Mycotaxon 81: 293–319.
- Baker WA, Partridge EC, Morgan-Jones G. 2002b. Notes on Hyphomycetes LXXXVII. *Rhexoacrodictys*, a new segregate genus to accommodate four species previously classified in *Acrodictys*. Mycotaxon 82: 95–113.
- Baral HO. 1994. Über *Drepanopeziza verrucispora* und *Symphyosirinia clematidis* (Leotiales, Ascomycetes), mit einem Bestimmungsschlüssel der *Symphyosirinia*-Arten. Z. Mykol. 60: 211–224.
- Barron GL. 1968. The genera of Hyphomycetes from soil. Williams & Wilkins Company, Baltimore.
- Braun U. 1993. A monograph of *Cercospora*, *Ramularia* and allied genera (phytopathogenic Hyphomycetes). Vol. 2. IHW-Verlag, Eching.

- Carmichael JW, Kendrick WB, Connors IL, Sigler L. 1980. Genera of Hyphomycetes. University of Alberta Press, Edmonton.
- Ellis EA. 1956. *Symphyosirinia*, a new genus of inoperculate discomycetes. Trans. Norfolk Norwich Nat. Soc. 18: 5–17.
- Gams W. 1971. *Cephalosporium*-artige Schimmelpilze (Hyphomycetes). G. Fischer. Stuttgart.
- Gams W, Steiman R, Seigle-Murandi F. 1990. The hyphomycete genus *Goidanichiella*. Mycotaxon 38: 149–159.
- Goidànich G. 1935. Schema di una classificazione delle Stilbaceae, che erano riunite fin-ora nel genere *Graphium* Corda. Annali Bot. (Torino) 21: 40–50.
- Jülich W. 1974. Liste der im mykologischen Herbar von C. G. T. Preuss (†1855) vorhandenen Arten. Willdenowia 7: 261–331.
- Keissler K von. 1913. Über die Gattung *Symphyosira*. Mycol. Centbl. 2 (7): 321–325.
- McNeill J, Barrie FR, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema JH, Turland NJ, eds. 2006. International Code of Botanical Nomenclature (Vienna Code). Liechtenstein: Gantner Verlag, Ruggell.
- Nelson PE, Toussoun TA, Marasas WFO. 1983. *Fusarium* species, an illustrated manual for identification. Pennsylvania State Univ. Press, University Park, London.
- Nicot J, Charpentié M-J. 1971. Index des fungi imperfecti décrits par G. Arnaud (Mycologie concrète. Genera I et II). Bull. Trimestriel Soc. Mycol. France 87: 25–38.
- Nirenberg H. 1976. Untersuchungen über die morphologische und biologische Differenzierung der *Fusarium*-Sektion *Liseola*. Mitt. Biol. Bundesanst. Ld.- u. Forstw. 169: 1–117.
- Nirenberg HI, O'Donnell K. 1998. New *Fusarium* species and combinations within the *Gibberella fujikuroi* species complex. Mycologia 90: 434–458.
- Rossman AY, Samuels GJ, Rogerson CT, Lowen R. 1999. Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*). Stud. Mycol. 42: 1–248.
- Samuels GJ, Seifert KA. 1991. Two new species of *Nectria* with *Stilbella* and *Mariannaea* anamorphs. Sydowia 43: 249–263.
- Seifert KA. 1985 A monograph of *Stilbella* and some allied hyphomycetes. Stud. Mycol. 27: 1–235.
- Watling R, Kendrick B. 1979. *Osteomorpha* Arnaud – a validation. Naturalist 104: 1–4.

New or otherwise interesting lichens from the tropics, including the lichen genus *Ramboldia* in Thailand

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Abstract — *Acanthothecis dialeucoides*, *Gassicurtia marbachii*, *G. nordinii*, *Kalbographa lueckingii*, *Malcolmiella duplomarginata*, *M. pia* and *Ramboldia siamensis* are described as new to science. Range extensions are reported for *Diorygma soozanum* (from Thailand) and *Ramboldia haematites* (from Taiwan). *Graphina reniformis* var. *subasteroidea* is an *Acanthothecis* species of uncertain specific allocation. A key for the identification of *Ramboldia* species in Thailand is presented.

Key words — *Graphidaceae*, *Lecanoraceae*, *Physciaceae*, *Pilocarpaceae*

Introduction

Interest in tropical lichens has increased significantly during the last decade, resulting in many new monographs and contributions to the tropical lichen biota [e.g. Aptroot et al. (2008, 2009), Archer (2007), Bungartz et al. (2007), Cáceres (2007), McCarthy (ed., 2009), Frisch & Kalb (2006), Galloway (2007), Kalb et al. (2004), Lücking (2008), Lücking & Cáceres (2004), Marbach (2000), Moberg (2004), Rivas Plata et al. (2006), Sipman (2002)]. These (and many more) have extended our knowledge of lichenized fungi considerably. Nevertheless we are still far from having a complete inventory of these organisms occurring in tropical countries, and can only approach this goal step by step and this paper provides a further small step.

Materials and methods

Most of the material used for study is housed in the private herbarium of the senior author (KK), but specimens from herbaria such as B, G, H, M, RAMK and S were investigated for comparison. The lichens were examined with a

Wild M3Z Plan stereomicroscope and an Olympus BH-A research microscope. Sections were prepared using a freezing microtome Leitz Kryomat 1321 and mounted in tap water and lactophenol cottonblue. Photos were taken with a Nikon Coolpix 990 Digital-Camera adapted to one of the microscopes. Natural compounds were characterized by thin-layer chromatography (TLC) according to the methods standardized for lichen products (Culberson 1972, Elix & Ernst-Russell 1993), and by high-performance liquid chromatography (HPLC) (Elix et al. 2003).

Taxonomic descriptions

Acanthothecis dialeuroides Kalb & Staiger, sp. nov.

MYCOBANK MB 514129

Similis *A. dialeuca*, sed *ascosporis maioribus, cum solutione Lugol reagentibus et thallo acidum sticticum deficienti differt.*

TYPE: REPUBLIC OF SOUTH AFRICA. Mpumalanga: near Lydenburg; F. Wilms s.n., comm. G. Lahm (M – holotype). [The original label is in Latin and says: “Corticolam prope urbem Lydenburg in Republica Transvaalica Africae meridionalis, leg. Dr. F. Wilms. Comm. Dr. G. Lahm”].

ETYMOLOGY: the epithet refers to the similarity with *Acanthothecis dialeuca*.

THALLUS corticolous, whitish to cream-coloured, thin, smooth to cracked areolate. ASCOCARPS numerous, short, straight or bent, rarely branched, 0.5–1 × 0.2–0.3 mm. EXCIPLE uncarbonised, poorly developed, pale orange at the base, laterally rudimentary. HYMENIUM c. 90 µm high, not inspersed. Paraphyses parallel or in the upper part of the hymenium rarely anastomosing, tips warty, hyaline or yellowish-brown. PERIPHYSOIDS not seen. ASCOSPORES 4–6/ascus, hyaline, muriform, 7–11 × 3–5-locular, 30–47 × 16–19 µm, I+ blue-violet.

CHEMISTRY: no substances detectable by TLC.

DISCUSSION: This lichen was identified as *Graphina socotrana* [sic!] by Müller [= *Acanthothecis socotrana* (Müll. Arg.) Staiger & Kalb 2002, as *A. socotrana*], but that species contains norstictic acid and the ascospores are I– and much narrower (10–15 µm in *A. socotrana* versus 16–19 µm in *A. dialeuroides*). The basionym for the *Acanthothecis* species from Socotra was *Diorygma socotranum* Müll. Arg. (Müller 1882a) and not *D. socotrinum* as cited by Staiger (2002). Therefore, the basionym orthography used in the original publication should be adopted, although Müller recombined the name later the same year using a variant orthography, *Graphina socotrana* (Müller 1982b).

Diorygma soozanum (Zahlbr.) M. Nakan. & Kashiw., Bull. Natl. Sci. Mus., Tokyo, B (Botany) 29(2): 86 (2003).

This lichen, originally described as a *Graphina* species, was recently transferred to *Diorygma* (Nakanishi et al. 2003) but not cited in Aptroot et al. 2007. Although

the chemistry of the Thai collections is more complex than mentioned in the monograph of the genus (Kalb et al. 2004), we have no doubt that they belong to this species. In addition to the major compound, norstictic acid, we found stictic, connorstictic and constictic acids as minor substances. The hymenium turns weakly blue at the lateral parts when treated with Lugol's solution, contrary to *D. junghuhnii* (Mont. & Bosch) Kalb et al, 2002, where the hymenium turns completely blue-violet. *Diorygma soozanum* is also similar to *D. tuberculosum* (Stirt.) Kalb et al. 2004, but in that species the ascospores are not or only weakly amyloid, while in *D. soozanum* they turn violet in Lugol's solution.

The collections cited below are new additions to the Thai lichen biota.

SPECIMENS EXAMINED: THAILAND. NAKHON RACHASIMA PROVINCE: Khao Yai National Park: in a very disturbed tropical rainforest near the students' lodges (Ban krong kaew), between 14°26'18"N, 101°22'24"E and 14°22'02"N, 101°24'25"E, 760 m 13.III.2008, K. Kalb (hb. Kalb 36998). CHIANG MAI PROVINCE: Mae Rim district; in a dry *Dipterocarpus* forest along a big pond called 'Huay Tueng Tao Reservoir', c. 6 km NNW of Chiang Mai. 18°52'11"N, 98°56'28"E, c. 360 m. 16.III.2008, K. Kalb, K. Buarueng & S. Jariangprasert (hb. Kalb 37125, RAMK). Foothills of Doi Suthep-Pui near Mae Rim, Queen Sirikit Botanic Garden, NE of Chiang Mai, in a dry, open *Dipterocarpus* forest, between 18°53'16"N, 98°51'47"E, 850 m and 18°54'33"N 98°51'17"E, 870 m. 18.III.2008, K. Kalb, K. Buarueng, S. Jariangprasert, W. Polyiam T. Pooprang & W. Saipunkaew (hb. Kalb 336930, RAMK). Medicinal garden, in a ± open *Cinchona* plantation near Doi Suthep-Pui National Park, ENE of Chiang Mai, 18°48'22"N, 98°54'53"E, 1085 m. 17.III.2008, K. Kalb, K. Buarueng, S. Jariangprasert & W. Saipunkaew (hb. Kalb 36935). Doi Suthep-Pui National Park, ENE of Chiang Mai; trail to Monthanthan waterfall, in a humid *Dipterocarpus* forest, 18°49'00"N, 98°55'28"E, 700 m. 17.III.2008, K. Kalb, K. Buarueng, S. Jariangprasert & W. Saipunkaew (hb. Kalb 37066).

***Gassicurtia marbachii* Kalb & Elix, sp. nov.**

FIGS. 1, 2

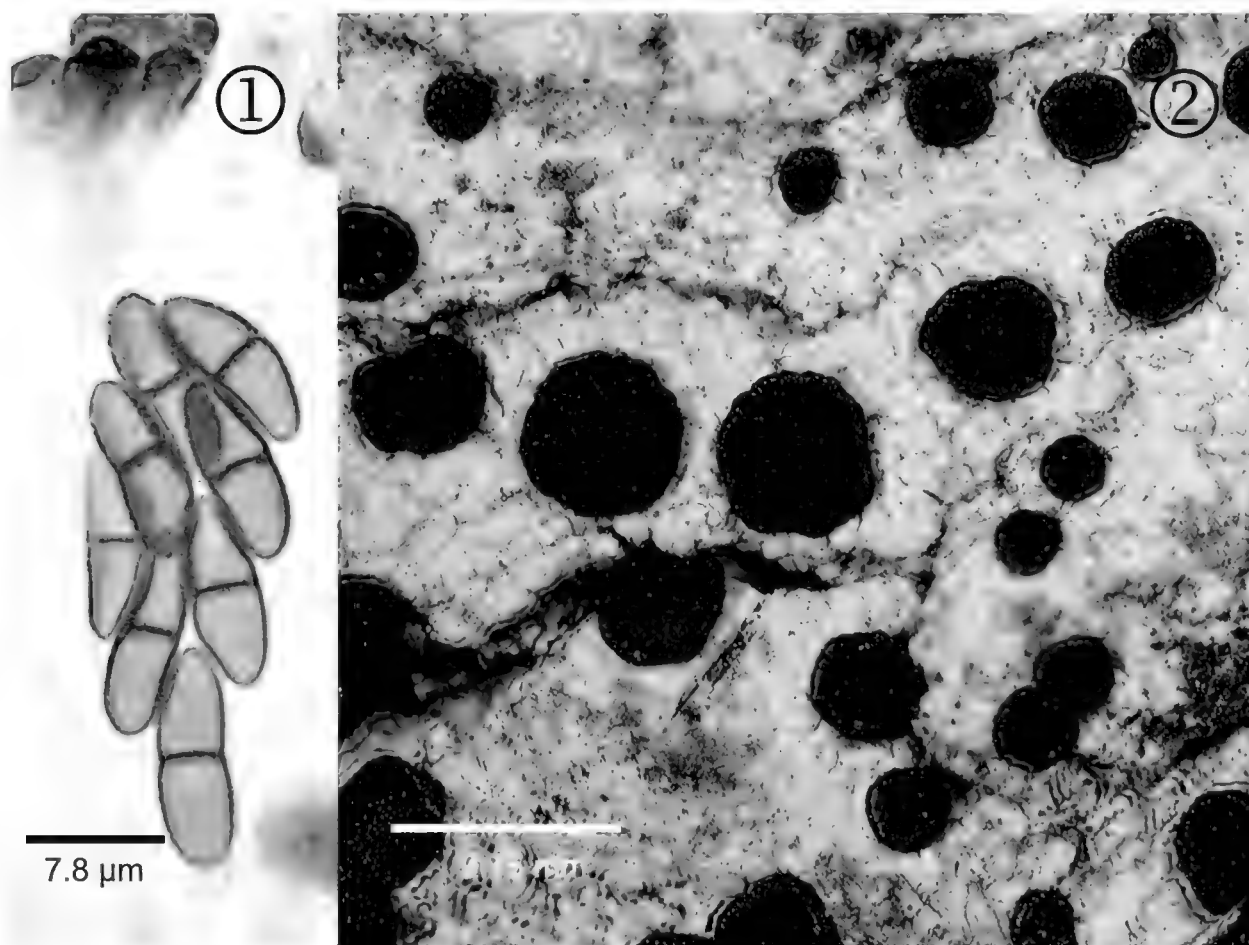
MYCOBANK MB 514130

Similis *G. vaccinii*, *sed ascosporis minoribus et acidum secalonicum* X (*maxime*), *2,7-dichloronorlichexanthonium* (*minus*), *atranorinum* (*minus*) *et acidum chiodectonicum* (*minime*) *continens differt*.

TYPE: KENYA. COAST PROVINCE: Kwale District, Shimba Hills, in a tropical rainforest, 350 m. 1.–2.IX.1985, K. Kalb & A. Schrögl 13115 (hb. Kalb – **holotype**).

ETYMOLOGY: the epithet honours the Austrian lichenologist Dr. Bernhard Marbach, who made considerable contributions to our knowledge of the systematics of corticolous *Buellia* species sensu lato and who resurrected Fée's genus *Gassicurtia*.

THALLUS corticolous, white, 50–70 µm thick, continuous, uneven to bullate, filled with many hyaline crystals. Phenocortex 5–10 µm thick, algal layer not distinctly separated, c. 10 µm thick, Algal cells chlorococcoid, 10–13 µm in diam. ASCOCARPS numerous, sessile, 0.3–0.6 mm diam., disc black, epruinose, with an inconspicuous, black proper margin, sometimes with a trace of purple due to chiodectonic acid, especially in the lower part, 0.02–0.03 mm thick, slightly prominent. EXCIPULUM laterally 30–50 µm thick, outer part dark

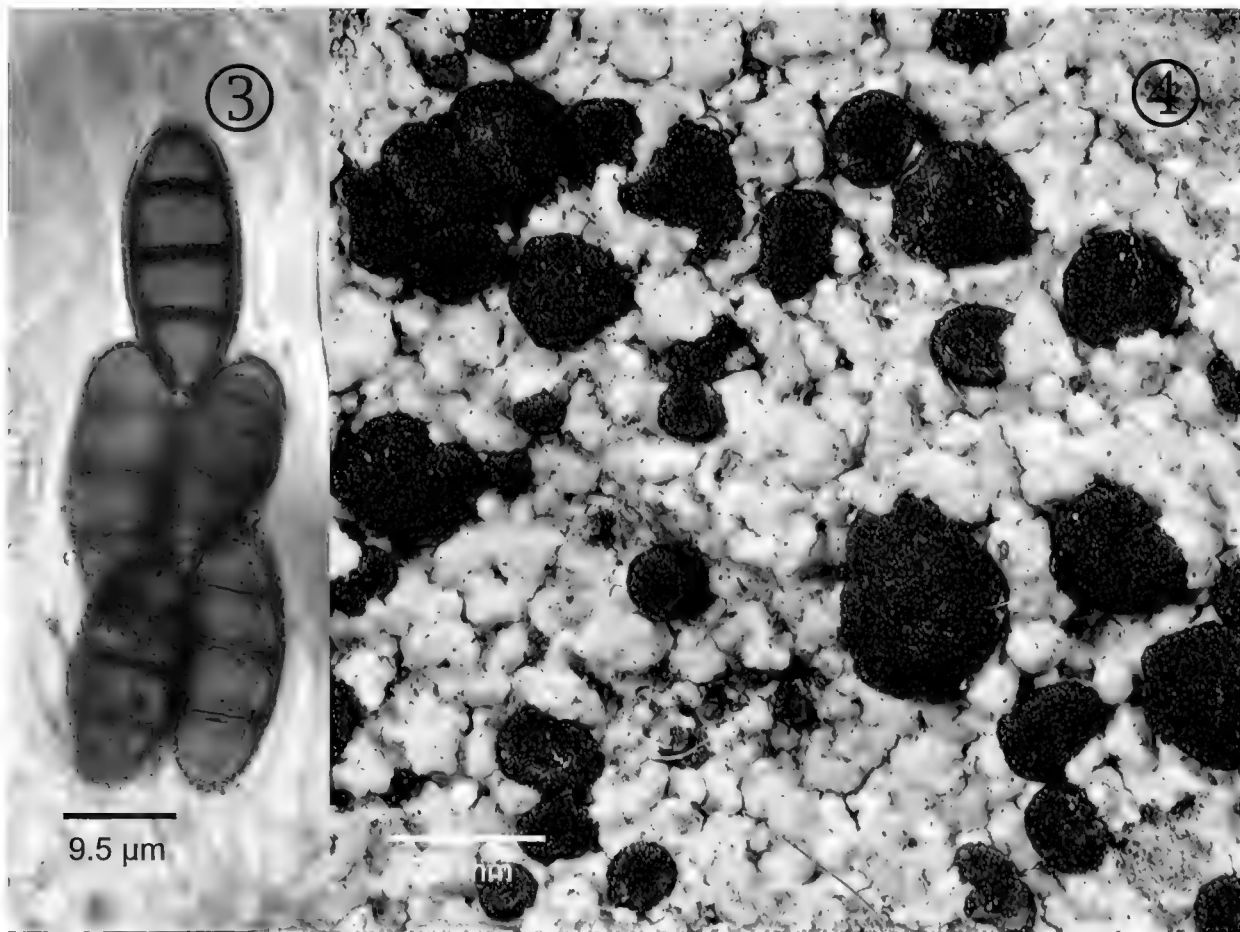


FIGURES 1–2. *Gassicurtia marbachii* (K. Kalb & A. Schrögl 13115).
1. Part of the hymenium with ascus and ascospores; 2. Part of the holotype.

brown to black, filled with crystals of chiodectonic acid, inner part brown. HYPOTHECIUM 80–120 µm high, dark brown. HYMENIUM 70–90 µm high, hyaline, not inspersed. PARAPHYSES simple, 1.5–2 µm thick, apically furcate, up to 5 µm thick with a brown cap. ASCOSPORES (6–)8/ascus, olive brown to chocolate brown, 1-septate, 10–11 × 3–4(–5) µm.

CHEMISTRY: secalononic acid X (major), 2,7-dichloronorlichexanthone, atranorin (both minor) and chiodectonic acid (trace). – HPLC, TLC by J.A. Elix.

DISCUSSION: Previously only two corticolous *Gassicurtia* species were known to contain secalononic acid derivatives, namely *G. coccinea* Fée 1825 (unknown secalononic acids) and *G. coccinoides* Marbach 2000 (secalononic acid X2). However, both differ in their major metabolites namely, thiophaninic acid in the former and boryquinone in the latter. *G. marbachii* contains 2,7-dichloronorliche xanthone, which is the first report of this xanthone in the genus *Gassicurtia*. *G. vaccinii* (Vain.) Marbach et al. (Marbach 2000) seems most closely related, but also differs in its chemistry (thiophanic acid and 3-*O*-methylthiophanic acid as major metabolites and arthothelin as a minor compound). Furthermore, that species has larger ascospores (15–16 × 5.5–6.5 µm) and lacks chiodectonic acid in the lateral exciple.

FIGURES 3–4. *Gassicurtia nordinii* (K. & A. Kalb 26149).

1. Part of the hymenium with ascus and ascospores (three ascospores missing);
2. Part of the holotype.

***Gassicurtia nordinii* Kalb & Elix, sp. nov.**

FIGS. 3, 4

MYCOBANK MB 514131

Similis *G. catasemae*, sed *ascosporis maioribus, triseptatis, et thallo 2-chlorolichexanthonom continenti differt.*

TYPE: MASCARENE ISLANDS: RÉUNION. Between le Brûlé (S of St-Denis) and Plaine des Cnicots, in a tropical rainforest with *Nastus borbonicus*, *Acacia heterophylla*, *Cyathea borbonica*, *Philippia montana*, etc., 20°57'S, 55°27'E, 1500 m. 15.VIII.1991, K. & A. Kalb 26149 (hb Kalb – holotype).

ETYMOLOGY: the epithet honours the Swedish lichenologist Dr. Anders Nordin for his significant contributions to our knowledge of *Buellia* species with pluriseptate ascospores.

THALLUS corticolous, whitish to cream-coloured, 100–200 µm thick, cracked areolate or bullate, partly subfoliose and ascending. Phenocortex 15–20 µm thick, algal layer not distinctly separated, up to 160 µm thick, Algal cells chlorococcoid, 10–13 µm in diam. ASCOCARPS numerous, sessile, 0.3–0.6 mm diam., disc black, epruinose, with an inconspicuous, black proper margin, 0.02–0.03 mm thick, not prominent. EXCIPULUM laterally 30–50 µm thick, outer part dark brown to black, inner part brown. HYPOTHECIUM 80–120 µm high, dark brown. HYMENIUM 70–90 µm high, hyaline, not inspersed. PARAPHYSES simple, 1.5–2 µm thick, apically furcate, up to 5 µm thick with a brown cap.

ASCOSPORES (6–)8/ascus, olive brown to chocolate brown, 3-septate, $17\text{--}23 \times 7\text{--}9 \mu\text{m}$.

CHEMISTRY: barbatic acid (major), chiodectonic acid, 2-chlorolichexanthone (both minor). – HPLC, TLC by J.A. Elix.

ADDITIONAL MATERIAL STUDIED: MASCARENE ISLANDS: RÉUNION. Just below the summit of Piton Maïdo, in a shrubbery composed of *Acacia heterophylla*, *Philippia montana*, *Hypericum lanceolatum*, 21°03'S, 55°23'E, 2200 m. 30.VIII.1991, K. & A. Kalb 26376 (hb. Kalb).

DISCUSSION: At present only two corticolous *Gassicurtia* species are known to contain barbatic acid as a major metabolite, namely *G. catasema* (Tuck.) Marbach 2000 and *G. elizae* (Tuck.) Marbach 2000. Both contain obtusatic acid as a minor substance and the former additional lichexanthone (Kalb & Elix 1998). *Gassicurtia nordinii*, however, contains 2-chlorolichexanthone and chiodectonic acid as minor substances. In addition, the new species is readily separated from all the other corticolous species of *Gassicurtia* by its 3-septate ascospores. In the general description of the genus, Marbach (2000) stated that the ascospores may be 1- or 3-septate, but all the species mentioned had only 1-septate ascospores.

Graphina reniformis var. *subasteroidea* Redinger, Ark. Bot. 26 A(1): 69 (1933).

TYPE: BRAZIL. MATO GROSSO: Serra da Chapada, Buriti. VI.1894, Malme 3520 (S-holotype!).

This material belongs in *Acanthothecis*, but a detailed examination located no ascospores and the chemistry alone, protocetraric acid, makes it impossible to assign this specimen to a particular species. Therefore, we regard the name as a 'nomen dubium'.

Three species of *Acanthothecis* from Brazil are known to contain protocetraric acid, namely *A. clavulifera* with trans-septate ascospores and *A. abaphoides* and *A. hololeuroides* with muriform ascospores. While *A. clavulifera* seems to be rare in Brazil, the latter two species are quite common.

Kalbographa lueckingii Kalb, sp. nov.

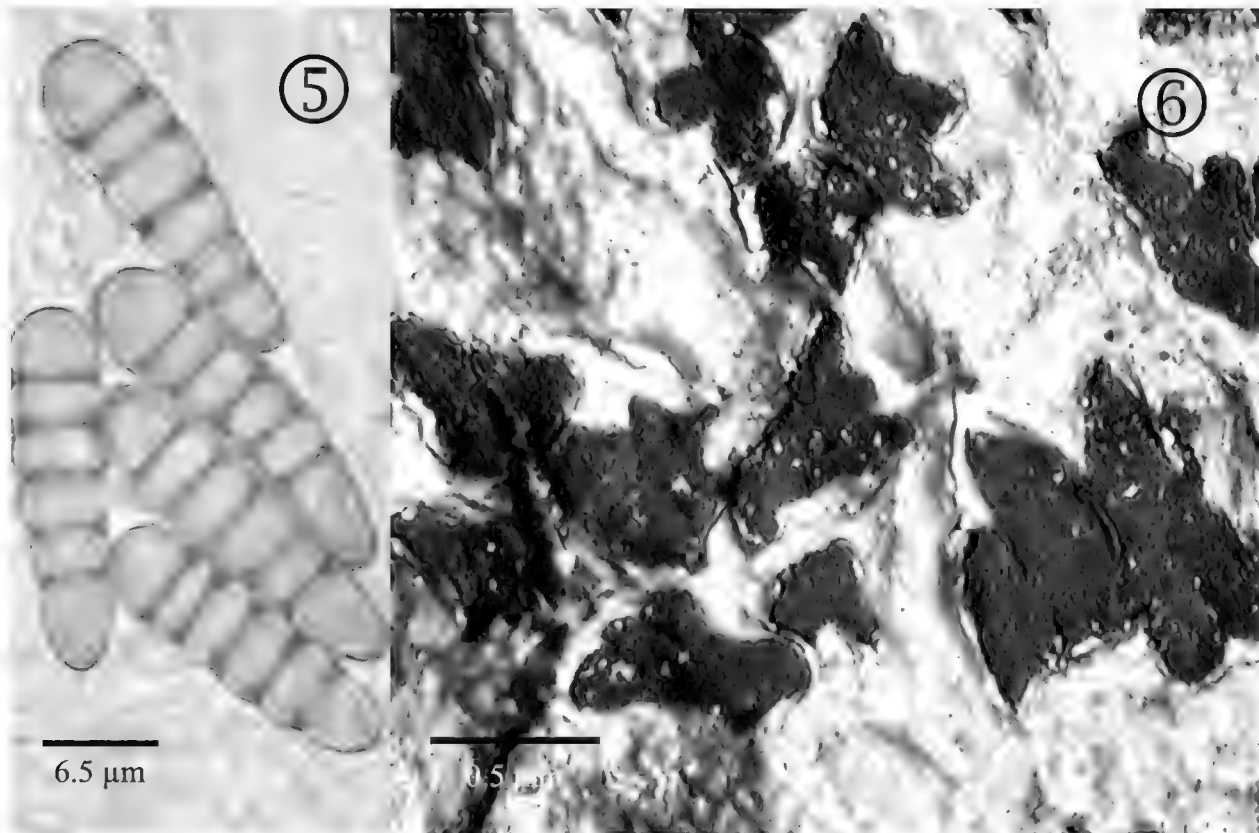
FIGS. 5, 6

MYCOBANK MB 514132

Similis Kalbographae lobatae, sed hymenio insperso, ascosporis solum transversaliter septatis et thallo acidum norsticticum continenti differt.

TYPE: HISPANIOLA. DOMINICAN REPUBLIC: La Vega; Trail from Jarabacoa to Salto Baiguate, c. 5 km S of Jarabacoa, on a free standing deciduous tree, 530 m. 19°04'N, 70°27'W, 17.VIII.1996, leg. K. Kalb 33152 (hb. Kalb – holotype)

ETYMOLOGY: The new species is dedicated to my friend and colleague, Dr. Robert Lücking, for his outstanding contributions to tropical lichens.



FIGURES 5–6. *Kalbographa lueckingii* (K. Kalb 33152).
1. Part of the hymenium with ascospores; 2. Part of the holotype.

THALLUS crustose, corticolous, continuous, 100–120 µm thick, smooth, whitish, phenocortex cartilaginous, 10–15 mm thick, algal layer 60–80 µm thick, with clusters of large calcium oxalate crystals, medulla indistinct, c. 10–30 µm thick, soralia and isidia absent. Photobiont *Trentepohlia*. APOTHECIA emerged to erumpent, angled to round or elongated, 0.4–1.2 × 0.2–0.3 mm, often some lirellae confluent and forming star-like aggregations; disc plane to slightly concave, dark brown to black, wide open, proper exciple indistinct or very thin, thalline margin indistinct or very thin. EXCIPLE in section c. 10 µm thick, brown, laterally and at the base bordered by thallus with clumps of large calcium oxalate crystals. SUBHYMENIUM 10–15 µm high, hyaline; HYPOTHECIUM 10–20 µm high, brown, K–. EPIHYMENIUM brownish, c. 10 µm high. HYMENIUM 40–60 µm high, hyaline, inspersed. ASCI clavate, 40–50 × 10–12 µm. ASCOSPORES brown, 8/ascus, with 5(–6) trans-septa, elongate ellipsoid, 18–23 × 6–7 µm, not halonate, I– (when young as well as mature). PYCNIDIA not observed.

CHEMISTRY: Norstictic acid (major) connorstictic acid (minor).

DISCUSSION: With the description of this new species the generic concept of the recently established genus (Lücking 2007) must be expanded. Previously all three known species have submuriform ascospores, a clear hymenium and no secondary lichen products in the thallus. But there are many other genera in the *Graphidaceae* (e.g. *Graphis*, *Phaeographis*, *Platythecium*, *Thelotrema*)

that contain species with and without an inspersed hymenium, with all types of ascospore septation, and with or without norstictic acid. Furthermore, the young, still hyaline, ascospores show no reaction with Lugol's solution. All these characters place the species very close to *Phaeographis*. However, in the phylogenetic tree presented by Staiger et al. (2006) (there named ?*Phaeographis* sp. BS5), *Kalbographa lueckingii* does not cluster within the monophyletic *Phaeographis* clade.

***Malcolmiella duplomarginata* Papong & Kalb, sp. nov.**

FIG. 7

MYCOBANK MB 514133

Similis Malcolmiellae graniferae, sed apotheciis excipulo thallino circumdatis et ascosporis maioribus differt.

TYPE: THAILAND. KANCHANABURI PROVINCE: Sai Yok District; Sai Yok National Park, in a dry evergreen forest, 35 m. 14°43'N, 98°85'E, 12.III.2009, K. Papong, 6557 (MSUT – holotype).

THALLUS crustose, corticolous, continuous, 50–80 µm thick, densely verrucose, green to green-grey, phenocortex c. 10–15 µm thick, with many small crystals, algal layer 30–55 µm thick, medulla indistinct, c. 10 µm thick, prothallus whitish, soralia and isidia absent. Verrucae 0.1–0.4 mm high and 0.1–0.3 mm wide. Medulla of verrucae and thallus cream to white, K+ orange. Photobiont chlorococcoid, cells 7–11 µm diam. APOTHECIA sessile, round, 0.7–1.5 mm diam. and 0.4–0.6 mm high; disc plane to slightly concave, bay-coloured; margin of *granifera*-type, thick, slightly prominent, white to cream coloured, surrounded by a continuous or granular layer of thalline exciple. THALLINE EXCIPLE c. 50 µm thick, densely filled with algal cells; PROPER EXCIPLE hyaline, with an internal medullary layer composed of loosely arranged, periclinal hyphae with constricted septa, 70–100 µm wide, incrustated with whitish to creamy hydrophobic granules, nebulous but dissolving in KOH to give a K+ lemon yellow to greenish yellow reaction. SUBHYMENIUM c. 25 µm high, brown; HYPOTHECIUM 40–60 µm high, blackish brown, K–. EPIHYMENIUM brownish. HYMENIUM 100–130 µm high, hyaline. ASCI 90–110 µm × 18–22 µm. ASCOSPORES 4–8/ascus, non-septate, wall equally thickened, halonate, ellipsoid, 20–24 × 11–15 µm, halo 2–3 µm thick. PYCNIDIA not observed.

CHEMISTRY: Atranorin (major), unknown eumitrin derivatives (minor).

ADDITIONAL SPECIMEN STUDIED: THAILAND. SAKON NAKHON PROVINCE: Phu Pan National Park, next to the repeated Television signal 5 Center, in a dry dipterocarp forest, 17°03'N, 103°58'E, 327 m. 9.IV.2009, K. Papong 6562 (MSUT).

DISCUSSION: The new species is quite remarkable and distinctive because of its thalline exciple surrounding the medullary exciple. This character is unique and not seen in any other species of the genus. Furthermore, only a few species (as yet unpublished) are known with ascospores larger than 20 µm.

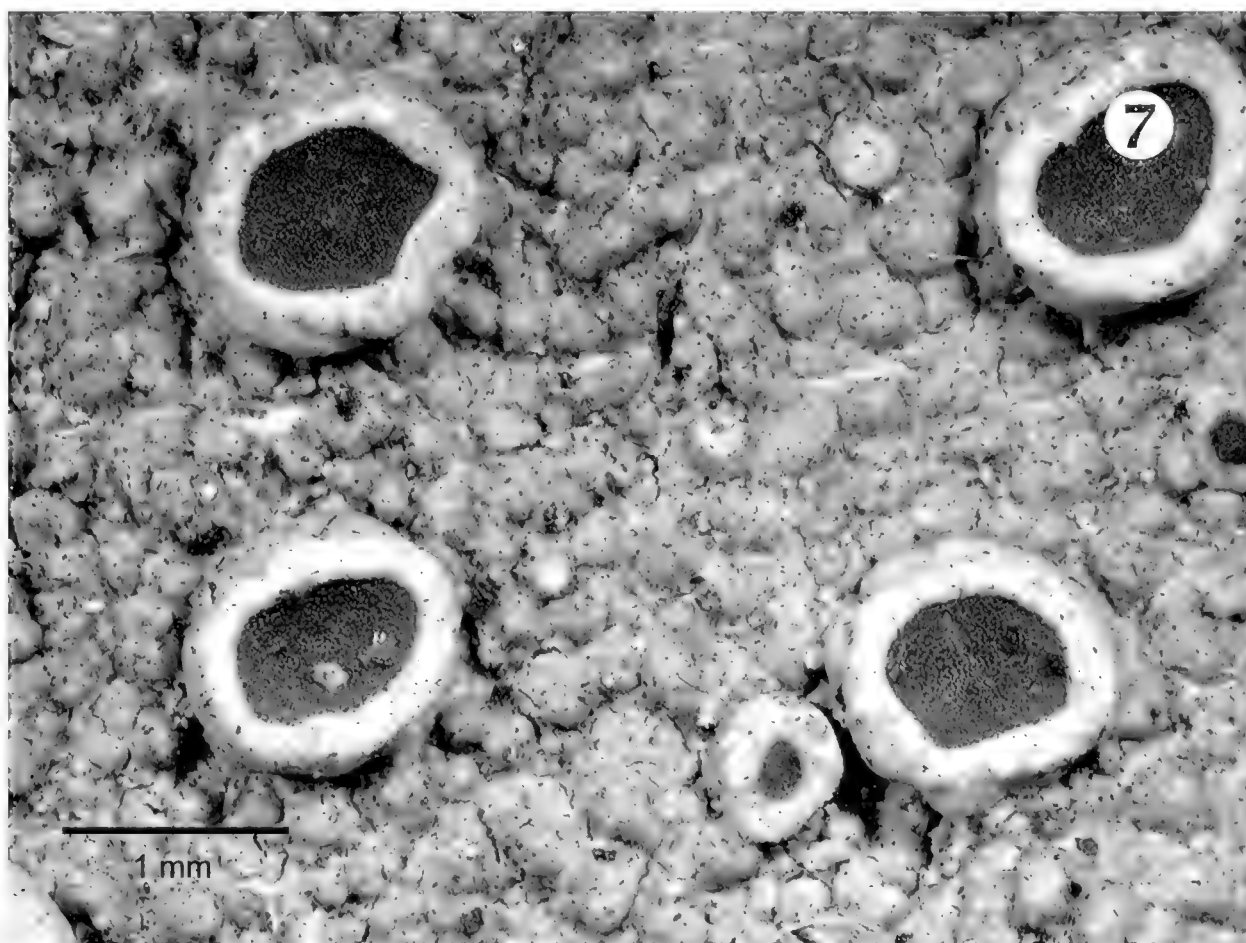


FIGURE 7. *Malcolmiella duplomarginata* (K. Papong, 6557); part of the holotype.

***Malcolmiella pia* Kalb, sp. nov.**

FIG. 8

MYCOBANK MB 514192

Similis *Malcolmiellae graniferae*, sed *thallo crassiore, verrucis coralloideis et ascosporis maioribus differt.*

TYPE: THAILAND. CHIANG MAI PROVINCE: foothills of Doi Suthep-Pui near Mae Rim, Queen Sirikit Botanic Garden NE of Chiang Mai, 18.III.2008, in a dry *Dipterocarpus* forest, 860 m. 18°54'33"N, 98°51'17"E, K. Kalb 36845 & S. Jariangprasert (RAMK – holotype, hb Kalb – isotype).

ETYMOLOGY: This new species is named in honour of Mrs S. Jariangprasert, called Pia, who was an expert guide during the senior author's (K. K.) visit to Chiang Mai and who showed this lichen to him in the field.

THALLUS corticolous, crustose, continuous, 50–80 µm thick, yellowish green to green-grey, densely verrucose, phenocortex c. 5–10 µm thick, with many small crystals, algal layer 20–40 µm thick, medulla indistinct, c. 20–30 µm thick, prothallus whitish, true soralia and isidia absent. Verrucae initially 0.1–0.2 mm wide and 0.2–0.3 mm high, becoming confluent with age and forming rather large and conspicuous coralloid clumps (to 0.5 mm wide and 0.6 mm high). Verrucae remaining closed or becoming erumpent at the apices and producing soredia-like corticate granules and exposing the medulla. Medulla of verrucae and thallus lemon yellow, K+ orange. Photobiont chlorococcoid, cells 7–11

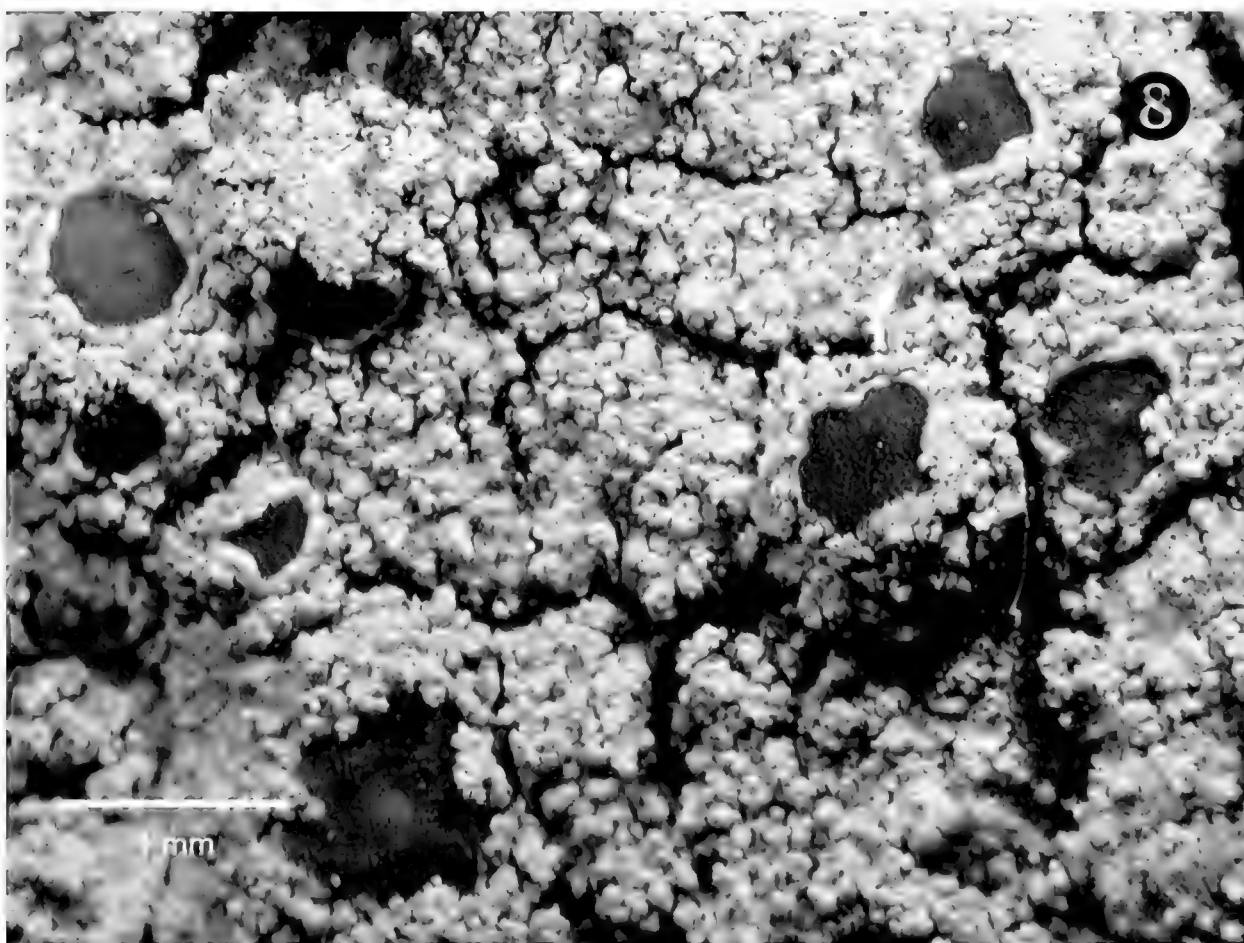


FIGURE 8. *Malcolmiella piae* (K. Kalb 36845); part of the Holotype.

µm diam. APOTHECIA sessile, round, 0.7–1.5 mm diam. and 0.4–0.7 mm high; disc plane to slightly convex, bay-coloured; margin of *granifera*-type, thick, entire, slightly prominent, white to cream coloured. EXCIPLE hyaline externally, with a medullary layer composed of loosely arranged, periclinal hyphae with constricted septa; the inner parts adjacent to hypothecium dark brown, 75–150 µm wide; hyaline parts incrustated with whitish to creamy hydrophobic granules, nebulous but dissolving in KOH to give a K⁺ lemon yellow to greenish yellow reaction. SUBHYMENIUM c. 25 µm high, brown; hypothecium 60–150 µm high, blackish brown, K[–]. EPIHYMENIUM brownish. HYMENIUM 150–200 µm high, hyaline. Asci 80–100 µm × 18–22 µm. ASCOSPORES (2–)4–8/ascus, non-septate, wall equally thickened, halonate, ellipsoid, 16–22 × 9–12 µm, halo 1–2 µm thick. PYCNIDIA not observed.

CHEMISTRY: Atranorin (major), eumitrin F, (major), eumitrin D (minor), usnic acid (trace), unknown cf. contortin (anal. J. Elix, TLC, HPLC).

ADDITIONAL SPECIMEN STUDIED: **Thailand**. CHIANG MAI PROVINCE: Mae Rim district; in a dry *Dipterocarpus* forest along a big pond called “Huay Tueng Tao Reservoir”, c. 6 km NNW from Chiang Mai, 360 m. 18°52'11"N, 98°56'28'E, K. Kalb, K. Buarueng, & S. Jariangprasert (hb. Kalb 37054). – **Australia**. NORTHERN TERRITORY: Kakadu National Park, “Gungarre Monsoon Forest” near South Alligator, 75 m. 12°41'S, 132°29'E, K. & A. Kalb (hb. Kalb 30436, 35171).

DISCUSSION: The development of the verrucae is very similar to those in *Dirinaria aegialita* (Afzel. ex Ach.) B.J. Moore 1968 or *Pyxine coralligera* Malme 1897, most accurately described by Swinscow & Krog (1978). The new species is similar to *Malcolmiella granifera* (Ach.) Kalb & Lücking 2000, but in this species the verrucae never become coralloid and the ascospores are significantly smaller ($10\text{--}15 \times 6\text{--}9 \mu\text{m}$). Sterile thalli of *M. piae* also resemble warted or papillose populations of *Megalospora sulphurata* Meyen 1843, but they are readily separated by their alternative chemistry (usnic acid and zeorin in the latter). Cochromatography of the Australian collections with the holotype revealed an identical array of (mostly unknown) eumitrin derivatives.

Ramboldia russula (Ach.) Kalb, Lumbsch & Elix, Nova Hedwigia 86(1–2): 37 (2008).

This species was mentioned in Wolseley et al. (2002), but at that time it was not distinguished from *R. haematites* (Fée) Kalb et al. 2008, which also has a pantropical distribution. As yet we have not found the latter species in Thailand. The two species can readily be separated by their chemistry, i.e. fumarprotocetraric acid (major), lichexanthone (major to trace or not detectable by TLC), russulone, norrussulone and secalononic acid A in *R. russula* and lichexanthone (major–minor), norstictic acid (major), connorstictic acid (major–minor) and russulone in *R. haematites*.

SPECIMENS STUDIED: THAILAND. CHIANG MAI PROVINCE: Queen Sirikit Botanic Garden, on unidentified tree, 700 m. in a dry dipterocarp forest, W. Khamthim, 3.III.1998 (RAMK 2949); on *Holigarna kurzii*, K. Boonpragob, 17.I.1995 (RAMK 2945); $18^{\circ}48'22''\text{N}$, $98^{\circ}54'53''\text{E}$, 1085 m. K. Kalb et al. 17.III.2008 (hb. Kalb 36936, RAMK); Lumphun, Mae On, ESE of Chiang Mai, descent from Doi Mon Larn to Mae Kam Pong village, in an evergreen mountain forest dominated by *Lithocarpus*, *Quercus* and *Castanopsis*, c. $18^{\circ}51'22''\text{N}$, $99^{\circ}22'02''\text{E}$, c. 1500 m. 19.III.2008, K. Kalb, K. Buarueng, W. Polyiam & W. Saipunkaew. (hb. Kalb 36914, RAMK). Medicinal garden, in a \pm open *Cinchona* plantation near Doi Suthep-Pui National Park, ENE of Chiang Mai, $18^{\circ}48'22''\text{N}$, $98^{\circ}54'53''\text{E}$, 1085 m. 17.III.2008, K. Kalb, S. Jariangprasert, K. Buarueng & W. Saipunkaew (hb. Kalb 36774*); PHITSANULOK PROVINCE: Phu Hin Rong Kla National Park, Lan Hin Tak, on *Quercus austrocochinchinensis* in lower montane scrub, $17^{\circ}00'16''\text{N}$, $100^{\circ}56'57''\text{E}$, 935 m. 3.II.2003, N. Homchantara (RAMK 2944*); same locality, Lan Hin Pum, on *Rhododendron* spec., 1175 m. 3.VI.2003, C. Thunyagun (RAMK 2951*).

COMMENTS: In the collections marked with an asterisk, lichexanthone could not be detected by means of TLC. As we could not find any anatomical or morphological differences in the specimens with this xanthone, we consider it of no taxonomic consequence. Interestingly, in one collection (RAMK 2951) the UV- and the UV+ forms are growing close together on the same piece of bark, separated from one another by a dark prothalline line. More material and molecular genetic studies are necessary to resolve this problem.

Ramboldia siamensis Buaruang, Elix & Kalb, sp. nov.

FIG. 9

MYCOBANK MB 514134

Similis R. heterocarpae, sed colore thalli et materia chemica differt.

TYPE: THAILAND. PHITSANULOK PROVINCE: Phu Hin Rong Kla National Park, Lan Hin Taek, on sandstone (siliceous rocks), 980 m in lower montane scrub, 17°00'27"N, 100°59'36"E, C. Phraphuchamnong, K. Papong and J. Sutjaritturakan, 27.VII.2002 (RAMK 2934 – **holotype**, RAMK 2937 – isotype). Chemistry: Fumarprotocetraric acid (major), lichexanthone (major), parietin (minor), emodin (minor), chrysophanol (minor), russulone, norrussulone, unknown sekalonic acid (anal. J. Elix, TLC, HPLC).

ETYMOLOGY: The specific name is derived from Siam, the historic name for Thailand.

THALLUS usually saxicolous, rarely corticolous, crustose, superficial, creamy white, creamy grey or pale ochre, sometimes with orange dots at the edges of areoles, continuous, areolate to bullate, 0.2–0.4 mm thick; areoles irregularly shaped to angular, 0.2–0.7 mm wide, upper surface smooth to rough, lacking soredia and isidia. Prothallus not apparent. Cortex 30–50 µm thick, lacking an epinecral layer; medulla white, but orange in part; algal layer c. 30–50 µm thick; algal cells 6–9 µm wide. APOTHECIA common, dispersed to crowded, sessile, 0.5–1.3 mm wide, convex to ± flat, round to irregular in shape, dark red or red-brown, shiny, epruinose. TRUE EXCIPLE concolorous with the disc, thin, persistent or excluded with age; EPITHECIUM red or orange-red, interspersed with fine reddish granules, K+ reddish purple; HYMENIUM colourless, I+ blue, 100–120 µm tall; HYPOTHECIUM deep orange-red, 100 µm thick; PARAPHYSES strongly conglutinated, mostly simple; apices not conspicuously swollen, 2–3 µm wide. ASCI 8-spored, broadly clavate, c. 40 × 10 µm. ASCOSPORES 8/ascus, elongate-ellipsoid, colourless, smooth, lacking a distinct perispore, 9–11 × 3.0–3.5 µm. PYCNIDIA visible as black dots, immersed; conidia filiform, curved, 20–25 × 1 µm.

CHEMISTRY: Fumarprotocetraric acid (major), lichexanthone (major to trace), parietin (minor), emodin (minor), chrysophanol (minor), unknown sekalonic acid derivative (trace), russulone, norrussulone.

ADDITIONAL SPECIMENS EXAMINED: THAILAND. PHITSANULOK PROVINCE: Phu Hin Rong Kla National Park, Lan Hin Taek, on sandstone (siliceous rocks), in lower montane scrub, 17°00'27"N, 100°59'36"E, 1010 m. C. Phraphuchamnong, K. Papong & J. Sutjaritturakan, 27.VII.2002 (RAMK 2938, 2931, 2941), same locality, K. Buaruang, C. Phraphuchamnong & N. Homchantara, 6.II.2003 (RAMK 2942); Phitsanulok: Phu Hin Rong Kla National Park, view point of Lan Hin Taek, on sandstone (siliceous rocks) in lower montane scrub, 17°00'27"N, 100°59'36"E, 1010 m. C. Phraphuchamnong, K. Papong & J. Sutjaritturakan, 27.VII.2002 (RAMK 2930); Phitsanulok: Phu Hin Rong Kla National Park, 500 m right hand side of the multipurpose court, on sandstone and conglomeratic sandstone, 17°00'27"N, 100°59'36"E, 1010 m. C. Phraphuchamnong, 10.V.2003 (RAMK 2935, 2936); same locality, along the way to the state office, on sandstone (siliceous rock) in lower montane scrub, 17°00'27"N, 100°59'36"E, 1180 m. C. Phraphuchamnong, 8.V.2003 (RAMK 2932, 2933); LOEI PROVINCE: Phu Loung wildlife sanctuary behind a sign of Phu Loung wildlife sanctuary, on sandstone (siliceous rock), in lower montane scrub, C. Phraphuchamnong, 29.VIII.2005 (RAMK 2940); same

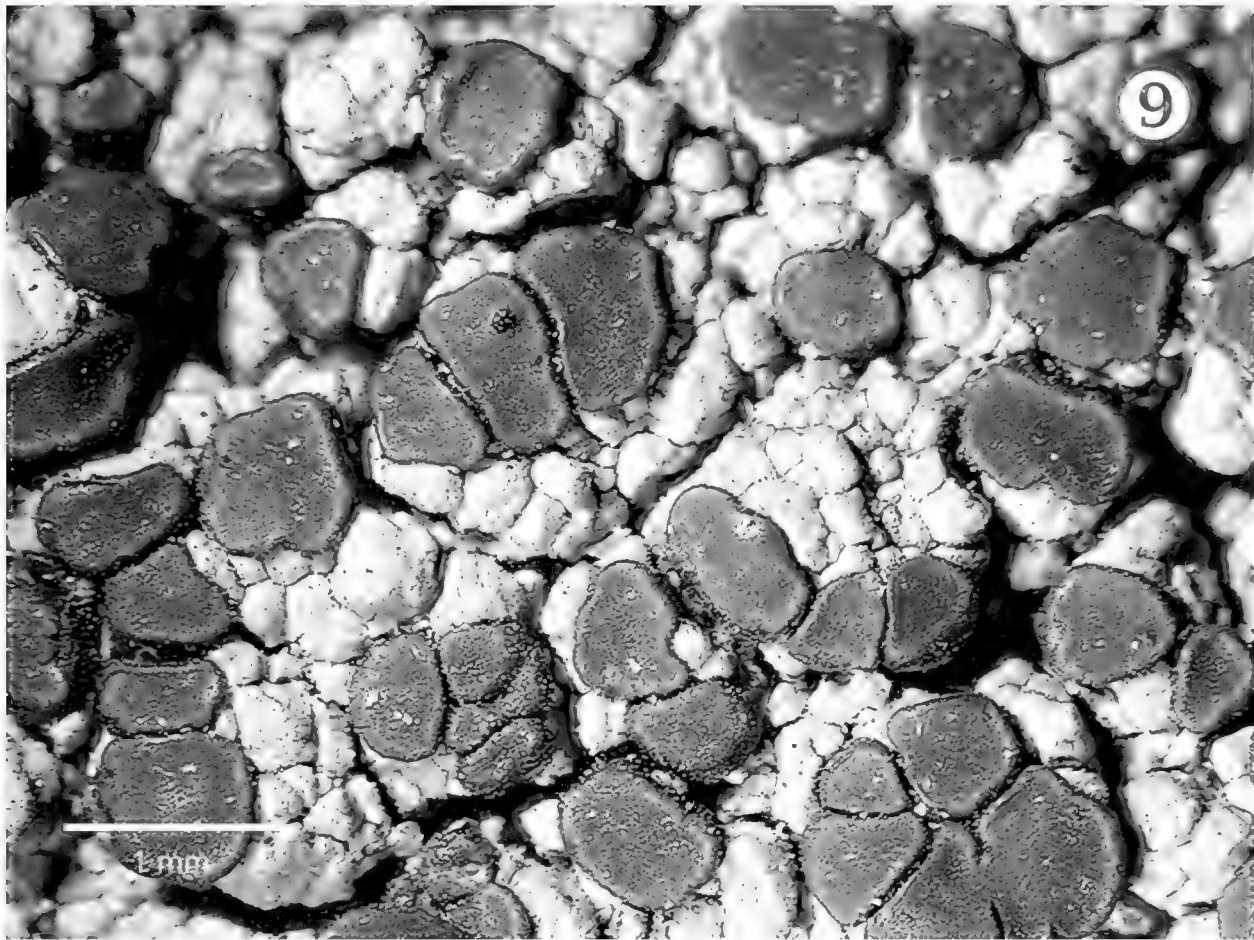


FIGURE 9. *Ramboldia siamensis* (RAMK 2934); part of the holotype.

locality, Phu Suan Sai, Toko, on *Castanopsis*, 1260 m. W. Khanthim, 12.VII.1995 (RAMK 2946*) – NAKHON RATCHASIMA PROVINCE: Khao Yai National Park, Khao Khaeo, on unidentified tree in a submontane evergreen forest, W. Polyiam, 12.III.2000 (RAMK 2947*).

COMMENTS: The collections, marked with an asterisk, are corticolous and show similar chemistry to the type except that lichexanthone was not detected by TLC.

Previously, only two species of *Ramboldia* were known from Thailand with certainty; however we have added *R. haematites* to the key, as it might be expected to occur here. Two collections from Taiwan cited below represent a new addition to the lichen biota of that country (Kalb et al. 2008, Aptroot & Sparrius 2003, reported as *Pyrrhospora russula*). Both specimens exhibited the same chemistry, i.e. lichexanthone (minor), norstictic acid (major), secalononic acid A (minor), russulone (trace), connorstictic acid (trace). – HPLC, TLC by J.A. Elix.

TAIWAN. NANTOU COUNTY: 44 km WNW of Hualien, Meifeng, 51RUG146655, 2050 m. on *Michelia formosana* in broadleaf forest remnant in valley, Aptroot 52284 (ABL). – TAICHUNG COUNTY: 30 km ENE of Taichung, 7 km NW of Kukwan, along mountain trail, 51RTG9279, 1000–1300 m. on *Shiia* branches, Aptroot 53455 (ABL).

Key to *Ramboldia* species in Thailand

- 1a. Medulla of thallus with orange or orange-red dots, K+ violet, parietin and emodin present; usually saxicolous *Ramboldia siamensis*
- 1b. Medulla of thallus white throughout, K+ yellow-brown to brown, fumarprotocetraric acid present; usually corticolous 2
- 2a. Cortex of thallus K+ yellow turning red, norstictic acid present *Ramboldia haematites*
- 2b. Cortex of thallus K- *Ramboldia russula*

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Literature cited

- Aptroot A, Lücking R, Sipman HJM, Umaña L, Chaves JL. 2008. Pyrenocarpous lichens with bitunicate asci: A first assessment of the lichen biodiversity inventory in Costa Rica. *Biblioth. Lichenol.* 97: 1–162.
- Aptroot A, Saipunkaew W, Sipman HJM, Sparrius LB, Wolseley P. 2007. New lichens from Thailand, mainly microlichens from Chiang Mai. *Fungal Diversity* 24: 75–134.
- Aptroot A, Sparrius LB. 2003. New microlichens from Taiwan. *Fungal Diversity* 14: 1–50.
- Aptroot A, Thor G, Lücking R, Elix JA, Chaves JL. 2009. The lichen genus *Herpothallon* reinstated. *Biblioth. Lichenol.* 99: 19–66.
- Archer AW. 2007. Key and checklist for the lichen family *Graphidaceae* (lichenised *Ascomycota*) in the Solomon Islands. *Syst. Biodiv.* 5(1): 9–22.
- Bungartz F, Nordin A, Grube M. 2007. *Buellia*. 113–179, in: TH Nash III et al. (eds.), *Lichen Flora of the Greater Sonoran Desert Region*. Volume 3. *Lichens Unlimited*, Tempe, Arizona State University.
- Cáceres ME. 2007. Corticolous crustose and microfoliose lichens of northeastern Brazil. *Libri Botanici* 22: 1–168.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *J. Chromat.* 72: 113–125.
- Elix JA, Ernst-Russell KD. 1993. A catalogue of standardized thin layer chromatographic data and biosynthetic relationships for lichen substances (2nd ed.). Australian National University, Canberra, 163 pp.

- Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. *Biblioth. Lichenol.* 86: 1–7.
- Frisch A, Kalb K. 2006. A monograph of *Thelotrema* with a complex structure of the columella. *Biblioth. Lichenol.* 92: 371–516.
- Galloway D. 2007. *Flora of New Zealand Lichens*. Revised second edition including lichen-forming and lichenicolous fungi. Volumes 1 and 2. Manaaki Whenua Press, Lincoln (New Zealand). i–cxxx + 2,261 pp.
- Kalb K, Elix JA. 1998. The chemistry of some species of *Buellia* sensu lato (*Lecanorales*, lichenized *Ascomycotina*). *Mycotaxon* 68: 465–482.
- Kalb K, Staiger B, Elix JA, Lange U, Lumbsch HT. 2008. A new circumscription of the genus *Ramboldia* (*Lecanoraceae*, *Ascomycota*) based on morphological and molecular evidence. *Nova Hedwigia* 86(1–2): 23–42.
- Kalb K, Staiger B, Elix JA. 2004. A monograph of the lichen genus *Diorygma* – a first attempt. *Symb. Bot. Upsal.* 34(1): 133–181.
- Lücking R. 2007. *Kalbographa*: Monografie einer unerkannten Flechtengattung. *Biblioth. Lichenol.* 96: 185–192.
- Lücking R. 2008. Follicolous lichenized fungi. *Flora Neotropica Monograph* 103: The New York Botanical Garden Press, New York (U.S.A.). 866 pp.
- Lücking R, Cáceres M. 2004. Corticolous species of *Trichothelium* (*Ascomycota*: *Porinaceae*). *Mycol. Res.* 108(5): 571–575.
- Lumbsch HAT, Huhndorf SM (eds.). 2007. Outline of *Ascomycota* – 2007. *Myconet* 13: 1–58.
- Marbach B. 2000. Corticole und lignicole Arten der Flechtengattung *Buellia* sensu lato in den Subtropen und Tropen. *Biblioth. Lichenol.* 74: 1–384.
- McCarthy PM. 2009. *Flora of Australia* vol. 57, Lichens 5. Canberra & Melbourne: ABRS and CSIRO Publishing.
- Moberg R. 2004. Notes on foliose species of the lichen family *Physciaceae* in southern Africa. *Symb. Bot. Upsal.* 8(1): 257–288.
- Müller J. 1882a. Diagnoses lichenum socotrensium novorum. *Proc. Roy. Soc. Edinburgh* 11: 457–472.
- Müller J. 1882b. Lichenologische Beiträge 15. *Flora* 65: 291–306, 316–322, 326–337, 381–386, 397–402.
- Nakanishi M, Kashiwadani H, Moon KH. 2003. Taxonomical notes on Japanese *Graphidaceae* (*Ascomycotina*), including some new combinations. *Bull. Natl. Sci. Mus., Tokyo, B (Botany)* 29(2): 83–90.
- Rivas Plata ETD, Lücking R, Aptroot A, Sipman HJM, Umana L, Chaves JL, Lizano D. 2006. A first assessment of the Ticolichen biodiversity inventory in Costa Rica: the genus *Coenogonium* (*Ostropales*: *Coenogoniaceae*). *Fungal Diversity* 23: 255–321.
- Sipman HJM. 2002. Lichens of mainland Yemen. *Willdenowia* 32: 127–135.
- Staiger B. 2002. Die Flechtenfamilie *Graphidaceae*. *Studien in Richtung einer natürlicheren Gliederung*. *Biblioth. Lichenol.* 85: 1–526.
- Staiger B, Kalb K, Grube M. 2006. Phylogeny and phenotypic variation in the lichen family *Graphidaceae* (*Ostropomycetidae*, *Ascomycota*). *Mycol. Res.* 110: 765–772.
- Swinscow TDV, Krog H. 1978. The genus *Dirinaria* in Africa. *Norw. J. Bot.* 25: 157–168.
- Wolseley PA, Aguirre-Hudson B, McCarthy PM. 2002. Catalogue of the lichens of Thailand. *Bull. Nat. Hist. Mus. London* 32(1): 13–59.

**Wood-inhabiting fungi in southern China 3.
A new species of *Phellinus* (*Hymenochaetales*)
from tropical China**

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Abstract — *Phellinus minisporus* sp. nov. is described and illustrated from Hainan and Yunnan provinces, southern China. It has resupinate basidiocarps, smaller pores, abundant hymenial setae, and its basidiospores are minute, broadly ellipsoid to subglobose, pale yellowish and fairly thick-walled. The new species is distinguished from the other species in the genus by having minute basidiospores ($2\text{--}2.5 \times 1.6\text{--}2\ \mu\text{m}$).

Key words — *Hymenochaetaceae*, lignicolous and poroid fungi, taxonomy

Introduction

Extensive studies on the *Hymenochaetaceae* in China were carried out recently, and many new species have been described from the country (Dai 1995, 1999; Dai et al. 1997, 2000, 2008a, b; Dai & Xu 1998, Dai & Zhou 2000, Dai & Zang 2002, Dai & Cui 2005, Dai & Yuan 2005, Dai & Niemelä 2006, Wang 2006, Cui & Dai 2008, Dai & Yang 2008, Xiong & Dai 2008). *Phellinus* Quél. is the largest genus in the *Hymenochaetaceae*, and more than 200 taxa are found in the world (Larsen & Cobb-Pouille 1990, Dai 1999, Núñez & Ryvarden 2000, Gibertoni et al. 2004, Ryvarden 2004, Parmasto 2007, Dai et al. 2008b, Dai & Yang 2008). Among them, about fifty species have been recorded from China (Dai 1999, Dai & Niemelä 2006, Dai et al. 2008 b, Dai & Yang 2008).

During the study on wood-inhabiting fungi in southern China, an unknown species of *Phellinus* was identified and described in the present paper.

Materials and methods

The studied specimens were deposited at the herbarium of Institute of Applied Ecology, Chinese Academy of Sciences (IFP), and the herbarium of Beijing Forestry University (BJFC). The microscopic procedure followed Cui et al. (2007). In presenting the variation in the size of the spores, 5% of measurements were excluded from each end of the range, and are given in parentheses. In the text the following abbreviations were used: IKI = Melzer's reagent, IKI- = negative in Melzer's reagent, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous, CB- = acyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = variation in the L/W ratios between the specimens studied, n = number of spores measured from given number of specimens. Sections were studied at magnification up to $\times 1000$ using a Nikon Eclipse E80i microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Special colour terms followed Petersen (1996) and Anonymous (1969).

Description

Phellinus minisporus B.K. Cui & Y.C. Dai, sp. nov.

FIG. 1

MYCOBANK MB 514081

Carpophorum perenne, resupinatum. Facies pororum fulva vel hinnulea; pori rotundi vel sinuolati, 8–11 per mm. Systema hypharum dimiticum, hyphae generatoriae septatae, efibulatae. Sporae late ellipsoideae vel subglobosae, crassitunicatae, IKI-, CB(+), 2–2.5 \times 1.6–2 μ m.

TYPE. — **China.** Hainan Province, Changjiang County, Bawangling Nature Reserve, on dead angiosperm tree, 3.IX.2006 Dai 7868 (holotype in BJFC, isotype in IFP).

ETYMOLOGY — *minisporus* (Lat.): referring to the minute basidiospores.

FRUITBODY — Basidiocarps perennial, resupinate, firmly attached to the substrate, not readily separable, no odour or taste when fresh, woody hard when dry, up to 12 cm long or more in longest dimension, 4 cm wide, and 4 mm thick at centre; sterile margin narrow to almost lacking, pale yellowish to yellowish brown, less than 1 mm wide. Pore surface yellowish brown to fawn brown, slighting shining; pores mostly circular, some slightly sinuous, 8–11 per mm; dissepiments thin, entire. Subiculum cinnamon brown to fawn brown, hard corky, ca. 0.1 mm thick. Tubes concolorous with pores, woody hard, up to 4 mm long, tube layers distinct.

HYPHAL STRUCTURE — Hyphal system dimitic; all septa without clamp connections; skeletal hyphae IKI-, CB-; tissue darkening but otherwise unchanged in KOH.

SUBICULUM — Generative hyphae hyaline to pale yellowish, fairly thick-walled with a wide lumen, rarely branched and frequently simple septate, 2–4.6 μ m in

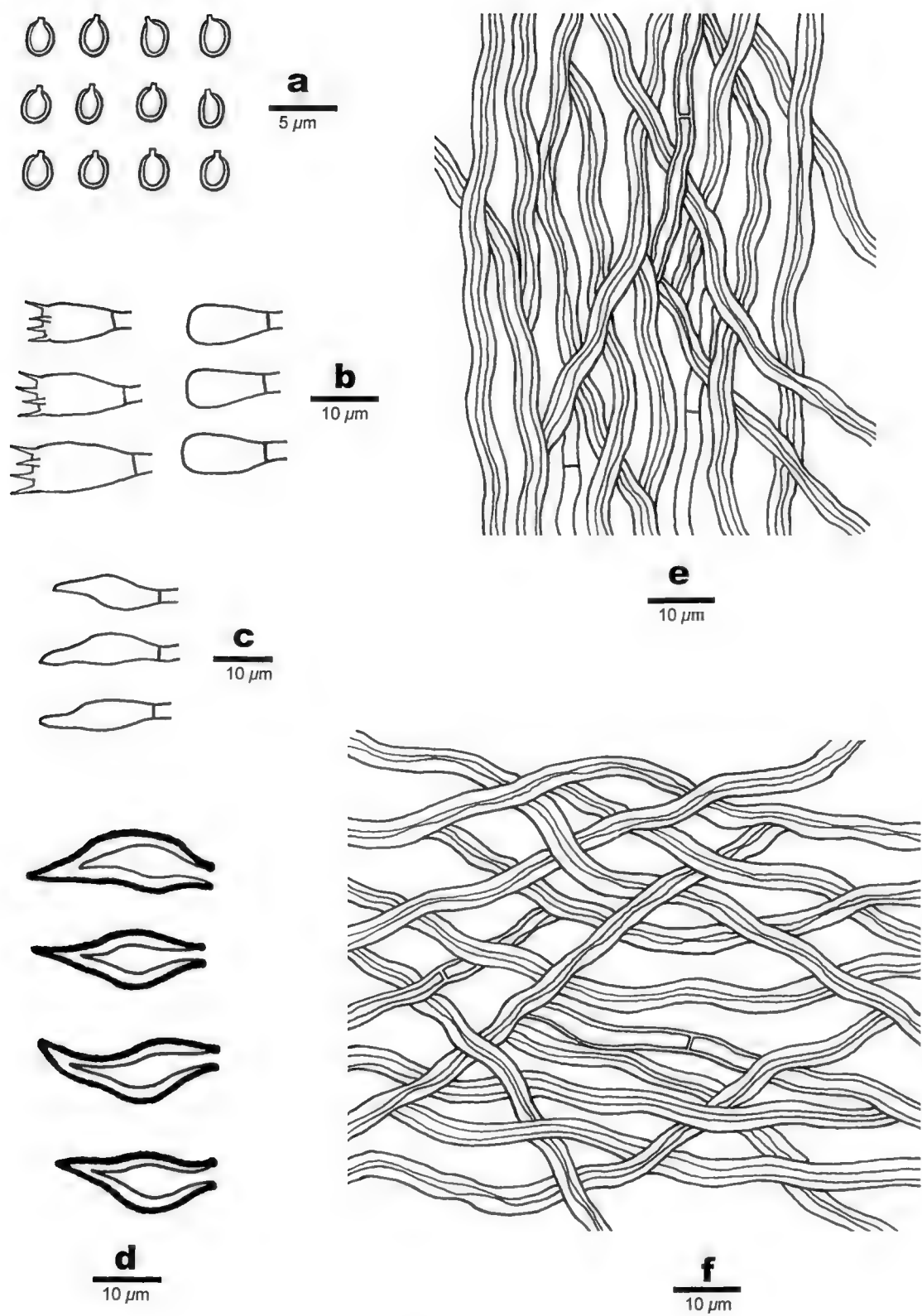


FIG. 1. Microscopic structures of *Phellinus minisporus* (drawn from the holotype).
—a: Basidiospores. —b: Basidia and basidioles. —c: Cystidioles. —d: Hymenial setae.
—e: Hyphae from tubes. —f: Hyphae from subiculum.

diam; skeletal hyphae yellowish brown to rust brown, thick-walled with a wide to narrow lumen, unbranched, loosely interwoven, 2.5–5.4 μm in diam.

TUBES — Generative hyphae hyaline to pale yellowish, thin- to slightly thick-walled, rarely branched, frequently simple septate, 1.7–3.6 μm in diam; skeletal hyphae yellowish brown to rust brown, thick-walled with a wide to narrow lumen, more or less straight, regularly arranged, agglutinated, 2.2–5 μm in diam. Hymenial setae frequent, ventricose to subulate, dark brown, thick-walled, 16–30 \times 5.4–9.5 μm . Cystidia absent, fusoid cystidioles occasionally present, 9.2–16.7 \times 3.5–5.6 μm ; basidia barrel-shaped, with four sterigmata and a simple septum at the base, 9–15 \times 4.6–7.5 μm ; basidioles in shape similar to basidia, but slightly smaller. Rhomboid crystals frequently present in trama and hymenia.

SPORES — Basidiospores broadly ellipsoid to subglobose, pale yellowish, fairly thick-walled, smooth, IKI–, weakly to moderately CB+, (1.8–)2–2.5(–2.8) \times (1.5–)1.6–2(–2.3) μm , L=2.21 μm , W=1.92 μm , Q=1.12–1.2 (n=120/4).

ADDITIONAL SPECIMENS (PARATYPES) EXAMINED. — **China**. Yunnan Province, Mengla County, Xishuangbanna Nature Reserve, on fallen angiosperm branch, 16.IX.2007 *Yuan* 3586 & 3589 (BJFC & IFP). Guangxi Autonomous Region, Longzhou County, Nonggang Nature Reserve, on fallen angiosperm trunk, 4.VII.2007 *Zhou* 170 (BJFC & IFP).

TYPE OF ROT — White rot.

REMARKS — *Phellinus minisporus* has resupinate basidiocarps, smaller pores, abundant hymenial setae, and minute, broadly ellipsoid to subglobose, pale yellowish and fairly thick-walled basidiospores. These characters distinguished it from other species in the genus.

Four species in *Phellinus*, *P. cesatii* (Bres.) Ryvarden 1972, *P. ferrugineovelutinus* (Henn.) Ryvarden 1972, *P. glaucescens* (Petch) Ryvarden 1972, and *P. purpureogilvus* (Petch) Ryvarden 1972, have resupinate basidiocarps, ventricose setae and small, colored basidiospores (Larsen & Cobb-Poullé 1990, Dai 1999), however, the basidiospores of the above species are more or less bigger than those of *Phellinus minisporus*: 3.3–4.1 \times 2.5–3.1 μm in *P. cesatii* (Dai 1999), 2.5–3.3 \times 2–2.5 μm in *P. ferrugineovelutinus* (Dai 1999), 3.5–4 \times 3–3.5 μm in *P. glaucescens* (Larsen & Cobb-Poullé 1990), 3.5–4.5 \times 3–4 μm in *P. purpureogilvus* (Larsen & Cobb-Poullé 1990).

Phellinus rufitinctus (Berk. & M.A. Curtis ex Cooke) Pat. 1900 may be confused with *P. minisporus* by having similar smaller basidiospores, however, it has tramal setal hyphae, and its basidiospores are hyaline and thin-walled (Gilbertson & Ryvarden 1987, Larsen & Cobb-Poullé 1990, Ryvarden 2004).

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Literature cited

- Anonymous. 1969. Flora of British fungi. Colour identification chart. Her Majesty's Stationery Office, London.
- Cui BK, Dai YC. 2008 Wood-rotting fungi in eastern China 2. A new species of *Fomitiporia* (*Basidiomycota*) from Wanmulin Nature Reserve, Fujian Province. *Mycotaxon* 105: 343–348.
- Cui BK, Dai YC, Decock C. 2007. A new species of *Perenniporia* (*Basidiomycota*, *Aphylllophorales*) from eastern China. *Mycotaxon* 99: 175–180.
- Dai YC. 1995. Changbai wood-rotting fungi 3. The genus *Phellinidium* (*Basidiomycetes*) and a new species, *P. aciferum*. *Ann. Bot. Fennici* 32: 63–73.
- Dai YC. 1999 *Phellinus* sensu lato (*Aphylllophorales*, *Hymenochaetaceae*) in East Asia. *Acta Bot. Fennici* 166: 1–115.
- Dai YC, Cui BK. 2005. Two new species of *Hymenochaetaceae* from eastern China. *Mycotaxon* 94: 341–347.
- Dai YC, Cui BK, Decock C. 2008a. A new species of *Fomitiporia* (*Hymenochaetaceae*, *Basidiomycota*) from China based on morphological and molecular characters. *Mycological Research* 112: 375–380.
- Dai YC, Cui BK, Tao WQ. 2008b. *Phellinus mori* sp. nov. (*Basidiomycota*, *Hymenochaetales*) from northern China. *Mycotaxon* 105: 53–58.
- Dai YC, Niemelä T. 2006. *Hymenochaetaceae* in China: hydroid, stereoid and annual poroid genera, plus additions to *Phellinus*. *Acta Botanica Fennica* 179: 1–78.
- Dai YC, Niemelä T, Zang M. 1997. Synopsis of the genus *Inonotus* (*Basidiomycetes*) sensu lato in China. *Mycotaxon* 65: 273–283.
- Dai YC, Xu MQ. 1998. Studies on the medicinal polypore, *Phellinus baumii*, and its kin, *P. linteus*. *Mycotaxon* 67: 191–200.
- Dai YC, Yang F. 2008. A new species of *Phellinus* (*Basidiomycota*, *Hymenochaetales*) from western China. *Mycotaxon* 104: 103–106.
- Dai YC, Yuan HS. 2005. *Inocutis subdryophila* (*Basidiomycota*), a new polypore from China. *Mycotaxon* 93: 167–171.
- Dai YC, Zang M. 2002. *Fomitiporia tibetica*, a new species of *Hymenochaetaceae*. *Mycotaxon* 83: 217–222.
- Dai YC, Zhang XQ, Zhou TX. 2000. Changbai wood-rotting fungi 12. Species of *Hymenochaete* (*Basidiomycota*). *Mycotaxon* 76: 445–450.
- Dai YC, Zhou TX. 2000. A new species of *Inonotus* (*Basidiomycotina*) from Yunnan, southern China. *Mycotaxon* 74: 331–335.
- Gibertoni TB, Ryvarden L, Cavalcanti MAQ. 2004. Studies in neotropical polypores 18. New species from Brazil. *Synopsis Fungorum* 18: 44–56.
- Gilbertson RL, Ryvarden L. 1987. North American polypores 2. *Megasporoporia* - *Wrightoporia*. *Fungiflora*, Oslo. pp. 434–885.
- Larsen MJ, Cobb-Poulsen LA. 1990. *Phellinus* (*Hymenochaetaceae*). A survey of the world taxa. *Synopsis Fungorum* 3: 1–206.
- Núñez M, Ryvarden L. 2000. East Asian polypores 1. *Ganodermataceae* and *Hymenochaetaceae*. *Synopsis Fungorum* 13: 1–168.

- Parmasto E. 2007. *Phellinus laevigatus* s.l. (*Hymenochaetales*): a ring species. *Folia Cryptog. Estonica* 43: 39–49.
- Petersen JH. 1996. Farvekort. The Danish Mycological Society's colour-chart. Foreningen til Svampekundskabens Fremme, Greve.
- Ryvarden L. 2004. Neotropical polypores part 1. Introduction, *Ganodermataceae* and *Hymenochaetaceae*. *Synopsis Fungorum* 19: 1–229.
- Wang HC. 2006. A new species of *Inonotus* (*Basidiomycetes*) from China. *Nova Hedwigia* 83: 137–142.
- Xiong HX, Dai YC. 2008. A new species of *Inonotus* (*Basidiomycota*, *Hymenochaetaceae*) from China. *Cryptogamie Mycologie* 29: 279–283.

Two new species of *Megasporoporia* (*Polyporales*, *Basidiomycota*) from tropical China

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Abstract — Two new polypores, *Megasporoporia ellipsoidea* sp. nov. and *M. violacea* sp. nov., found from tropical forests in Hainan Province of southern China, are described and illustrated. *Megasporoporia ellipsoidea* differs from other species in the genus by its cream to orange yellow pore surface, larger pores (1–1.5 per mm), barrel to calabash-shaped gloeocystidia, and ellipsoid basidiospores. *Megasporoporia violacea* is distinguished in the genus by having greyish violet to pale fawn brown pore surface, smaller pores (5–7 per mm), abundant dendrohyphidia, and cylindrical to oblong-ellipsoid basidiospores, and by lacking of hyphal pegs. An identification key to *Megasporoporia* species is provided.

Key words — lignicolous fungi, poroid fungi, taxonomy

Introduction

Megasporoporia Ryvarden & J.E. Wright was established by Ryvarden et al. (1982) based on *Poria setulosa* Henn. 1901. The genus is characterized by resupinate basidiocarps, large basidiospores, a dimitic to trimitic hyphal structure with clamped generative hyphae and dextrinoid skeletal hyphae, presence of rhomboid or bipyramidic crystals in hymenia, and species of the genus cause a white rot mostly on fallen angiosperm branches or twigs (Dai & Cui 2008, Zhou & Dai 2008).

Taxonomy and diversity of poroid wood-decaying fungi were studied intensively from China during recent years (Dai et al. 2003, 2007, 2008; Dai & Cui 2005, Cui & Dai 2006, 2008, Cui et al. 2007, 2008a, b). During the survey of wood-rotting fungi in the tropical forests of Jianfengling Nature

Reserve, Hainan Province, southern China, two collections were observed with characters fitting the genus *Megasporoporia* well, and they were described as two new species here.

Materials and methods

The studied specimens were deposited at the herbarium of the Institute of Microbiology, Beijing Forestry University (BJFC). Sections were studied at magnification up to $\times 1000$ by using a Nikon Eclipse E 80i microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Microscopic features, measurements and drawings were made from slide preparations stained with Cotton Blue and Melzer's reagent. Spores were measured from sections cut from the tubes (Cui et al. 2009). In presenting the variation in the size of the spores, 5% of measurements were excluded from each end of the range, and were given in parentheses. In the text of following abbreviations were used: IKI = Melzer's reagent, IKI- = negative in Melzer's reagent, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB+ = cyanophilous, CB- = acyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = variation in the L/W ratios between the specimens studied, n = number of spores measured from given number of specimens. Special colour codes followed Petersen (1996) and Anonymous (1969).

Descriptions

Megasporoporia ellipsoidea B.K. Cui & P. Du, sp. nov.

FIG. 1

MYCOBANK MB 514079

Carpophorum annuum, resupinatum. Facies pororum crenea bubalinua vel lutea; pori rotundi vel angulati, 1–1.5 per mm. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales subiculi 2.8–4.9 μm in diam. Sporae hyalinae, ellipsoideae, IKI-, CB-, 12–15 \times 6–8.2 μm .

TYPE. — China. Hainan Province, Ledong County, Jianfengling Nature Reserve, on fallen angiosperm branch, 18.XI.2007 Cui 5222 (holotype in BJFC).

ETYMOLOGY — *ellipsoidea* (Lat.): referring to the ellipsoid basidiospores.

FRUITBODY — Basidiocarps annual, resupinate, easily to separate from the substrate, no odour or taste when fresh, becoming corky upon drying, up to 10 cm long, 2 cm wide, and 0.8 mm thick at centre. Sterile margin distinct, orange yellow, up to 1 mm wide. Pore surface cream buff when fresh, becoming buff to orange yellow when dry; pores round to angular, 1–1.5 per mm; dissepiments thin, entire. Subiculum buff yellow to orange yellow, corky, azonate, up to 0.2 mm thick. Tubes concolorous with the pore surface, corky, up to 0.6 mm long, tube walls frequently covered with hyphal pegs.

HYPHAL STRUCTURE — Hyphal system dimitic; generative hyphae bearing clamp connections; skeletal hyphae very weakly dextrinoid, CB+; all hyphae unchanged in KOH.

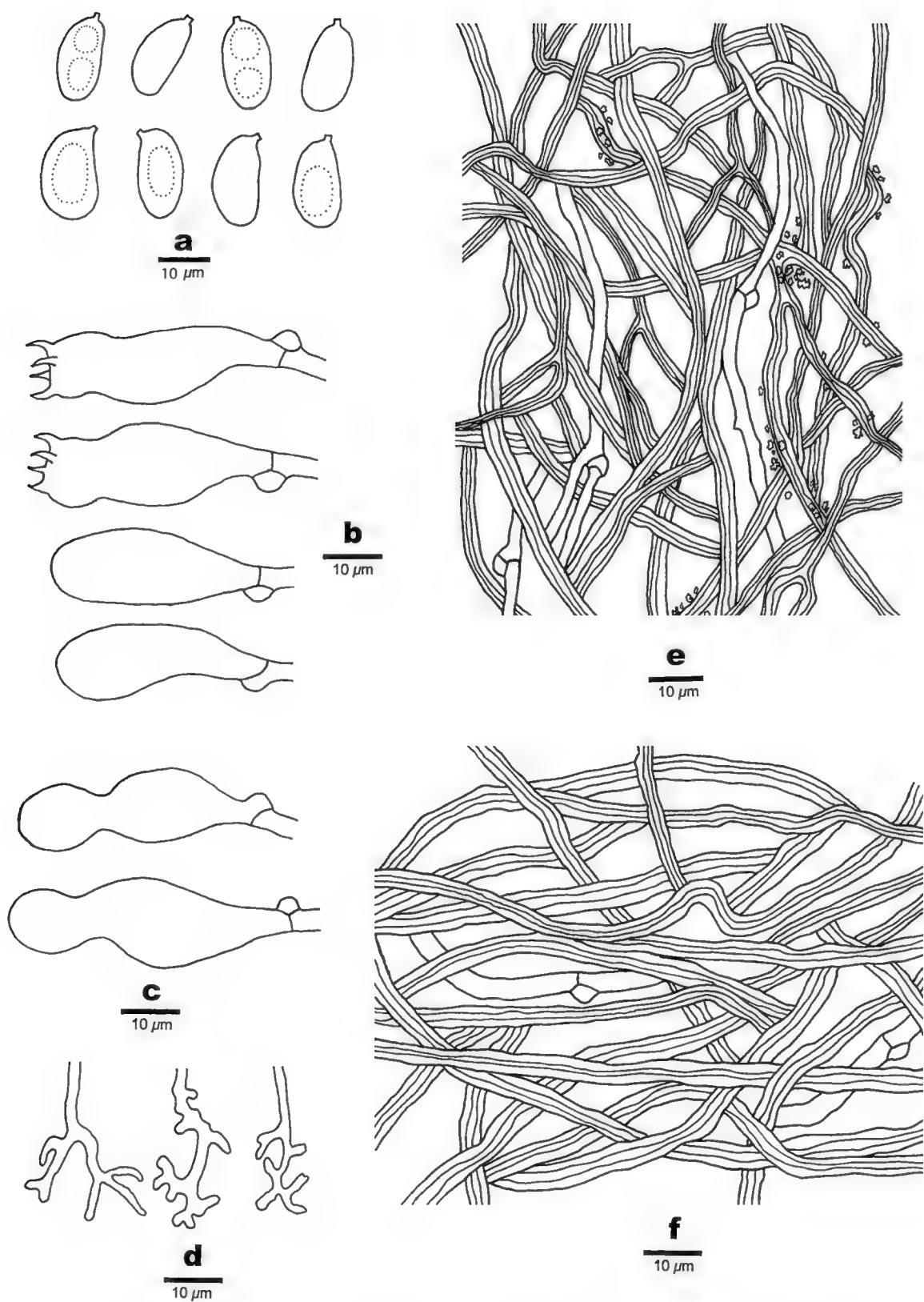


FIG. 1. Microscopic structures of *Megasporoporia ellipsoidea* (drawn from the holotype).
—a: Basidiospores. —b: Basidia and basidioles. —c: Gloeocystidia. —d: Dendrohyphidia.
—e: Hyphae from trama. —f: Hyphae from subiculum.

SUBICULUM — Generative hyphae infrequent, hyaline, thin-walled, occasionally branched, 2–3.2 µm in diam; skeletal hyphae dominant, thick-walled with a wide to narrow lumen, rarely branched, interwoven, 2.8–4.9 µm in diam.

TUBES — Generative hyphae infrequent, hyaline, thin-walled, occasionally branched, 1.8–2.8 μm in diam; skeletal hyphae dominant, thick-walled with a wide to narrow lumen, frequently branched, more or less straight to flexuous, sometimes coarsely encrusted, 2–3.7 μm in diam. Hyphae of hyphal pegs hyaline, thin- to fairly thick-walled, branched; dendrohyphidia frequently in hymenium and dissepimental edges, delicately branched in the upper part. Gloeocystidia present, barrel to calabash-shaped, thin-walled, smooth, 26–45 \times 11–15.3 μm . Basidia barrel-shaped, sometimes constricted, with a basal clamp connection and four sterigmata, 23–40 \times 9–15 μm ; basidioles barrel-shaped, distinctly smaller than basidia. Rhomboid or bipyramidic crystals frequently present.

SPORES — Basidiospores ellipsoid, hyaline, thin-walled, smooth, usually bearing one or two big guttules, IKI–, CB–, (11–)12–15(–18) \times 6–8.2(–9) μm , L=13.8 μm , W=7.18 μm , Q=1.92 (n=30/1).

REMARKS — *Megasporoporia ellipsoidea* is characterized by its cream to orange yellow pore surface and larger pores (1–1.5 per mm), calabash-shaped gloeocystidia, ellipsoid basidiospores. It may be confused with *M. major* (G.Y. Zheng & Z.S. Bi) Y.C. Dai & T.H. Li 2002, both have dendrohyphidia, hyphal pegs and similar pores, but the latter has cream to wood coloured pores with pale luteous margin, oblong ellipsoid to subcylindrical basidiospores (16–20 \times 5.5–7.1 μm), subulate and sharp-pointed cystidioles, and lacks gloeocystidia (Dai & Li 2002).

Megasporoporia ellipsoidea has similar basidiospores with *M. rhododendri* Y.C. Dai & Y.L. Wei 2004, however, the latter has smaller pores (4–5 per mm), lacks hyphal pegs and dendrohyphidia (Dai et al. 2004).

***Megasporoporia violacea* B.K. Cui & P. Du, sp. nov.**

FIG. 2

MYCOBANK MB 514080

Carpophorum annuum, resupinatum. Facies pororum violaceum vel violaceo-ardesiaceum; pori rotundi vel angulati, 5–7 per mm. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales subiculi 2–4.5 μm in diam. Sporae hyalinae, cylindricae, IKI–, CB–, 11–14.9 \times 3.2–5 μm .

TYPE. — China. Hainan Province, Ledong County, Jianfengling Nature Reserve, on fallen angiosperm branch, 11.V.2009 Cui 6570 (**holotype** in BJFC).

ETYMOLOGY — *violacea* (Lat.): referring to the violet pore surface.

FRUITBODY — Basidiocarps annual, resupinate, difficult to separate from substrate, hard corky, without odour or taste when fresh, becoming hard corky upon drying, up to 20 cm long, 3 cm wide, and 1 mm thick at centre. Sterile margin distinct, pinkish buff, up to 1 mm wide. Pore surface violet when fresh, greyish violet to pale fawn brown when dry; pores round to angular, 5–7 per mm; dissepiments thick, entire. Subiculum cream to pinkish buff, hard corky,

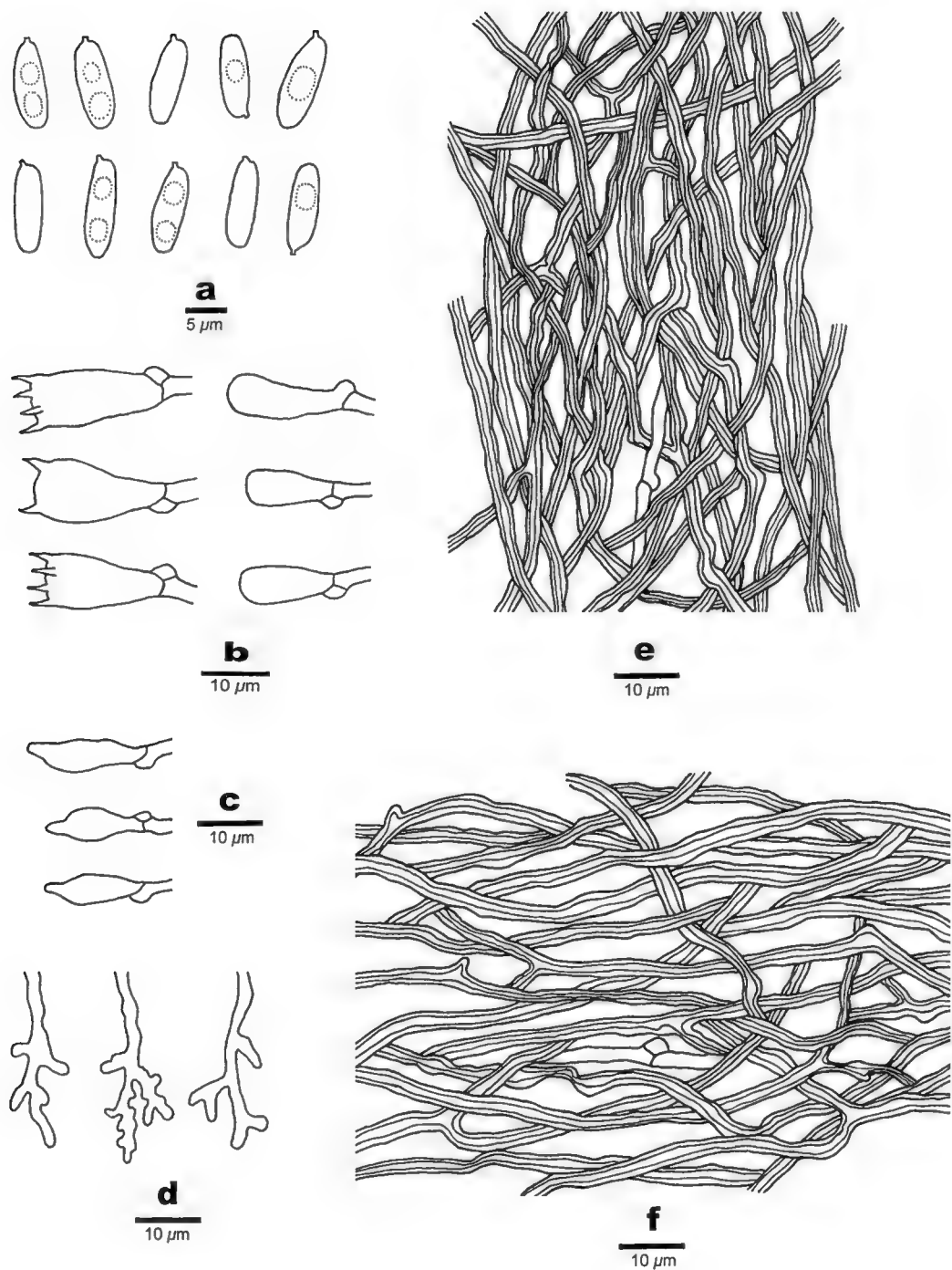


FIG. 2. Microscopic structures of *Megasporoporia violacea* (drawn from the holotype).
—a: Basidiospores. —b: Basidia and basidioles. —c: Cystidioles. —d: Dendrohyphidia.
—e: Hyphae from trama. —f: Hyphae from subiculum.

azonate, up to 0.2 mm thick. Tubes concolorous with the pore surface, corky, up to 0.8 mm long.

HYPHAL STRUCTURE — Hyphal system dimitic; generative hyphae bearing clamp connections; skeletal hyphae strongly dextrinoid, CB+; all hyphae unchanged in KOH.

SUBICULUM — Generative hyphae infrequent, hyaline, thin-walled, occasionally branched, 1.8–3 µm in diam; skeletal hyphae dominant, thick-walled with a wide to narrow lumen, frequently branched, mostly flexuous, interwoven, agglutinated, 2–4.5 µm in diam.

TUBES — Generative hyphae infrequent, hyaline, thin-walled, occasionally branched, 1.5–2.5 µm in diam; skeletal hyphae dominant, thick-walled with a wide to narrow lumen, frequently branched, flexuous, interwoven, 1.8–3.3 µm in diam. Dendrohyphidia present in hymenium and dissepimental edges, hyphal pegs absent. Cystidia absent; cystidioles present, subulate or ventricose, thin-walled, smooth, $9.8\text{--}15.8 \times 4\text{--}5$ µm. Basidia barrel-shaped, with a basal clamp connection and four sterigmata, $13\text{--}18.5 \times 5\text{--}9.8$ µm; basidioles basically clavate, distinctly smaller than basidia. Polyhedric crystals frequently present among subhymenium and hymenium.

SPORES — Basidiospores cylindrical, hyaline, thin-walled, smooth, usually bearing one or two big guttules, IKI–, CB–, $(10\text{--})11\text{--}14.9(-15.2) \times (3\text{--})3.2\text{--}5(-5.2)$ µm, $L=12.58$ µm, $W=4.22$ µm, $Q=2.83\text{--}3.16$ ($n=60/2$).

ADDITIONAL SPECIMEN (PARATYPE) EXAMINED — China. Hainan Province, Ledong County, Jianfengling Nature Reserve, on fallen angiosperm branch, 11.V.2009 Cui 6601b.

REMARKS — *Megasporoporia violacea* is unique in the genus by its distinct sterile margin, violet to greyish violet pore surface, smaller pores (5–7 per mm), presence of both cystidioles and dendrohyphidia, but lacking of hyphal pegs.

Megasporoporia violacea is similar to *M. cystidiolophora* B.K. Cui & Y.C. Dai 2007 by having cystidioles and similar basidiospores, but the latter has pale pinkish brown to salmon coloured pores. In addition, *M. cystidiolophora* has larger pores (3–5 per mm) and cystidioles ($17\text{--}23.2 \times 5.3\text{--}8$ µm), and it lacks dendrohyphidia (Cui & Dai 2007).

Megasporoporia minuta Y.C. Dai & X.S. Zhou 2008 was described from Guangxi Autonomous Region of southern China recently. It has smaller pores (6–8 per mm, Zhou & Dai 2008), which is similar to those of *M. violacea*, however, it has distinctly shorter basidiospores and lacks cystidioles and dendrohyphidia.

Ten species have previously been transferred to or described in the genus *Megasporoporia* (Ryvarden et al. 1982, Gilbertson & Ryvarden 1987, Dai & Wu 2004, Dai et al. 2004, Cui & Dai 2007, Dai & Cui 2008, Zhou & Dai 2008): *M. cavernulosa* (Berk.) Ryvarden 1982, *M. cystidiolophora*, *M. hexagonoides* (Speg.) J.E. Wright & Rajchenb. 1982, *M. major*, *M. mexicana* Ryvarden 1982, *M. minuta*, *M. quercina* Y.C. Dai 2004, *M. rhododendri*, *M. setulosa* (Henn.) Rajchenb. 1982, *M. subcavernulosa* Y.C. Dai & Sheng H. Wu 2004. An identification key to the species of *Megasporoporia* is provided.

Key to species of *Megasporoporia*

1. Basidiospores > 20 µm in length *M. mexicana*
1. Basidiospores < 20 µm in length 2
2. Basidiospores mostly < 3 µm in width *M. quercina*
2. Basidiospores mostly > 3 µm in width 3
3. Gloeocystidia present *M. ellipsoidea*
3. Gloeocystidia absent 4
4. Basidiospores > 16 µm in length 5
4. Basidiospores < 16 µm in length 6
5. Pores 0.5–1 per mm, pore surface ash grey *M. hexagonoides*
5. Pores 1–1.5 per mm, pore surface cream *M. major*
6. Pores 5–8 per mm 7
6. Pores 1–5 per mm 8
7. Basidiospores > 11 µm in length *M. violacea*
7. Basidiospores < 11 µm in length *M. minuta*
8. Dendrohyphidia present 9
8. Dendrohyphidia absent 10
9. Hyphal pegs present *M. subcavernulosa*
9. Hyphal pegs absent *M. cavernulosa*
10. Cystidioles absent *M. setulosa*
10. Cystidioles present 11
11. Basidiospores > 6 µm in width *M. rhododendri*
11. Basidiospores < 6 µm in width *M. cystidiolophora*

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We express our gratitude to Drs. Michal Tomsovsky (Brno, Czech Republic) and Zheng Wang (Yale University, USA) who reviewed the manuscript. The research was financed by the Ministry Science and Technology of China (Project No. 2008BADB0B03) and Beijing Forestry University (Project No. BLX2007014).

Literature cited

- Anonymous. 1969. Flora of British fungi. Colour identification chart. Her Majesty's Stationery Office, London. 1 p.
- Cui BK, Dai YC. 2006. *Wrightoporia* (Basidiomycota, Aphyllophorales) in China. Nova Hedwigia 83: 159–166.
- Cui BK, Dai YC. 2007. Polypores from Tianmushan Nature Reserve in Zhejiang Province, eastern China. Mikologiya Fitopatologiya 41: 506–514.
- Cui BK, Dai YC. 2008. *Skeletocutis luteolus* sp. nov. from southern and eastern China. Mycotaxon 104: 97–101.

- Cui BK, Dai YC, Decock C. 2007. A new species of *Perenniporia* (Basidiomycota, Aphyllophorales) from China. *Mycotaxon* 99: 175–180.
- Cui BK, Dai YC, Li BD. 2009. Notes on the genus *Rigidoporus* (Basidiomycota, Polyporaceae) in China. *Nova Hedwigia* 88: 189–197.
- Cui BK, Wang Z, Dai YC. 2008a. *Albatrellus piceiphilus* sp. nov. on the basis of morphological and molecular characters. *Fungal Diversity* 28: 41–48.
- Cui BK, Yuan HS, Dai YC. 2008b. Wood-rotting fungi in eastern China 1. Polypores from Wuyi Mountains, Fujian Province. *Sydowia* 60: 25–40.
- Dai YC, Cui BK. 2005. Two new species of the *Hymenochaetaceae* from eastern China. *Mycotaxon* 94: 341–347.
- Dai YC, Cui BK. 2008. Notes on *Megasporoporia* (Basidiomycota, Polyporales) in China. *Mycosystema* 4: 604–607.
- Dai YC, Cui BK, Decock C. 2008. A new species of *Fomitiporia* (Hymenochaetaceae, Basidiomycota) from China based on morphological and molecular characters. *Mycological Research* 112: 375–380.
- Dai YC, Harkönen M, Niemelä T. 2003. Wood-inhabiting fungi in southern China 1. Polypores from Hunan Province. *Annales Botanici Fennici* 40: 381–393.
- Dai YC, Li TH. 2002. *Megasporoporia major* (Basidiomycota), a new combination. *Mycosystema* 21: 519–521.
- Dai YC, Wei YL, Wang Z. 2004. Wood-inhabiting fungi in southern China 2. Polypores from Sichuan Province. *Annales Botanici Fennici* 41: 319–329.
- Dai YC, Wu SH. 2004. *Megasporoporia* (Aphyllophorales, Basidiomycota) in China. *Mycotaxon* 89: 379–388.
- Dai YC, Yuan HS, Zhang XQ, Wang Z. 2007. Systematic revisit of *Sparsitubus* (Basidiomycota, Aphyllophorales), an unusual cyphelloid-like polypore from China. *Fungal Diversity* 25: 37–47.
- Gilbertson RL, Ryvarden L. 1987. North American polypores 2. *Megasporoporia*–*Wrightoporia*. *Fungiflora*, Oslo. 885 pp.
- Petersen JH. 1996. Farvekort. The Danish Mycological Society's colour-chart. Foreningen til Svampekundskabens Fremme, Greve. 6 pp.
- Ryvarden L, Wright JE, Rajchenberg M. 1982. *Megasporoporia* a new genus of resupinate polypores. *Mycotaxon* 16: 172–182.
- Zhou XS, Dai YC. 2008. A new species of *Megasporoporia* (Polyporales, Basidiomycota) from China. *Mycological Progress* 7: 253–255.

Identity and neotypification of *Craterellus cinereus* and description of *Cantharellus atrofuscus* sp. nov.

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Abstract — The study of authentic specimens of *Cantharellus cinereus*, present in the Leiden Herbarium (L), has allowed us to ascertain the identity of this species, which has no clamp connections. There exists a species close to *Craterellus* (*Cantharellus*) *cinereus* distinguished by important macro- and microscopic features, including an unperforated basidioma and presence of clamp connections. This species is here proposed as new to science with the name *Cantharellus atrofuscus*. A description and photos of habit and microscopic characters are provided.

Keywords — *Basidiomycota*, *Agaricomycetes*, *Cantharellales*, taxonomy, Italy

Introduction

The problem of the identity of *Cantharellus cinereus*, i.e. *Merulius cinereus*, also known as *Craterellus cinereus*, has long been an enigma for the present authors because, judging from the literature and our personal collections, two different species have been described and illustrated under this name, with one species characterized by clamped hyphae (Corner 1966, Jülich 1989, Ellis & Ellis 1990, Romagnesi 1995) and the other by clampless hyphae (Kühner & Romagnesi 1953, Donk 1969, Marchand 1973, Bigelow 1978, Breitenbach & Kränzlin 1986, Persson & Mossberg 1994, 1998; Knudsen et al. 1997, Pegler et al. 1997, Watling & Gregory 1998).

*corresponding author

Donk (1969) was the first author to recognize the different interpretations of the taxon “*cinereus*”. In fact, when he discovered that Persoon’s authentic material preserved in Leiden consisted of basidiomata with clampless hyphae, he stated that the clamp-bearing species described by Corner as “*Cantharellus cinereus*” must represent another taxon. Similar observations were also made by Bigelow (1978), who, after studying some American clampless collections labeled as “*Craterellus cinereus* (Fries) Quélet”, noted that two different interpretations existed in the mycological literature: a clampless taxon described by Kühner & Romagnesi (1953) and ascribed to *Craterellus* Pers. and a clamped one referred by Corner (1966) to *Cantharellus* Juss. Bigelow (1978), who affirmed that it was impossible to distinguish the two taxa macroscopically, observed that *Cantharellus cinereus* s. Corner (1966) seemed to produce larger spores than the clampless species. For that reason he concluded that it was not possible to determine the real distribution of these two taxa, although he regarded *C. cinereus* s. Kühner & Romagnesi (1953) as more frequent and widespread than *C. cinereus* s. Corner (1966), at least judging from the spore sizes of collections cited in the literature.

In his cantharelloid monograph, Corner (1966) cited many descriptions and illustrations to support his concept of “*Cantharellus cinereus*”, emphasizing that he had examined collection 1777 Fungi Exsiccati Suecici (Lundell & Nannfeldt 1949) but failing to specify whether that material was clamped or not. Nevertheless he regarded his *Cantharellus cinereus* as “a true *Cantharellus*, both in the construction of the gill-folds and secondarily in the hollow nature of the pileus and stem.”

The description of *Merulius cinereus* given by Persoon (1801) is quite short but the data are definitely important; the Dutch author described *Merulius cinereus* as “caespitosus, pileo subinfundibuliformi squamuloso nigrescente, plicis cinereis nitidis, stipite cavo nigrescente” growing “in faginetis, locis apertis” and different from *Merulius cornucopioides* in possessing well formed gill-like folds. In this description “*Helvella hydrolips* Bull. Hist. d. champ. 1. p. 212. t. 565. f. 1” was recorded as a variety of *M. cinereus*.

Our only opportunity to ascertain the real identity of Persoon’s agaric was to examine the authentic material conserved in Leiden (L). For this reason, M. Carbone visited that herbarium and examined all the collections labeled “*Merulius cinereus*”.

Below we provide the results of this revision; we clarify the concept of *Craterellus cinereus* and describe the species exhibiting clamp connections as new to science.

Materials and methods

The description of macroscopical features of *Cantharellus atrofuscus* sp. nov. (vide infra) is based on fresh material. Micro-features of *C. atrofuscus* and Persoon’s material are

based on dried specimens, rehydrated in L4 or KOH 5% solutions, and then mounted in Red Congo to observe the hymenium and pileipellis, and in water for spore dimensions. L4 is a solution composed by water, KOH, NaCl, Invadin Ciba, phenol, and glycerine.

The number of the measured spores has involved many specimens and many collections, in order to calculate a reliable range of spore dimensions. We chose all the spores present in the visual field to satisfy the random principle. Basidiospore measurements do not include the apiculus. Spore dimensions are described as Length (mean – mean square deviation)–(mean + mean square deviation) × Width (mean – mean square deviation)–(mean + mean square deviation). The following abbreviations are used: Q = the spore quotient (length/width ratio); Qm = the average spore quotient; Vm = the average spore volume.

Author citations are according to the IPNI Authors website and the Index Fungorum Authors of Fungal Names website.

Cantharellus cinereus

In the National Herbarium Nederland of Leiden (L) there are two folders labeled “*Merulius cinereus* Pers.” The first includes four collections: 1) L0111397 nr. 910.255-41 (labeled “type”); 2) L0111398 nr. 910.255-27; 3) L0111399 nr. 910.255-61; 4) L0111400 nr. 910.255-47. The second folder includes a single collection, L0111401 nr. 910.255-19.

First folder

Handwriting on the herbarium sheets shows that collections 1–3 were already revised by Donk, who reported his observations in Donk (1969). M. Carbone’s reexamination results follow:

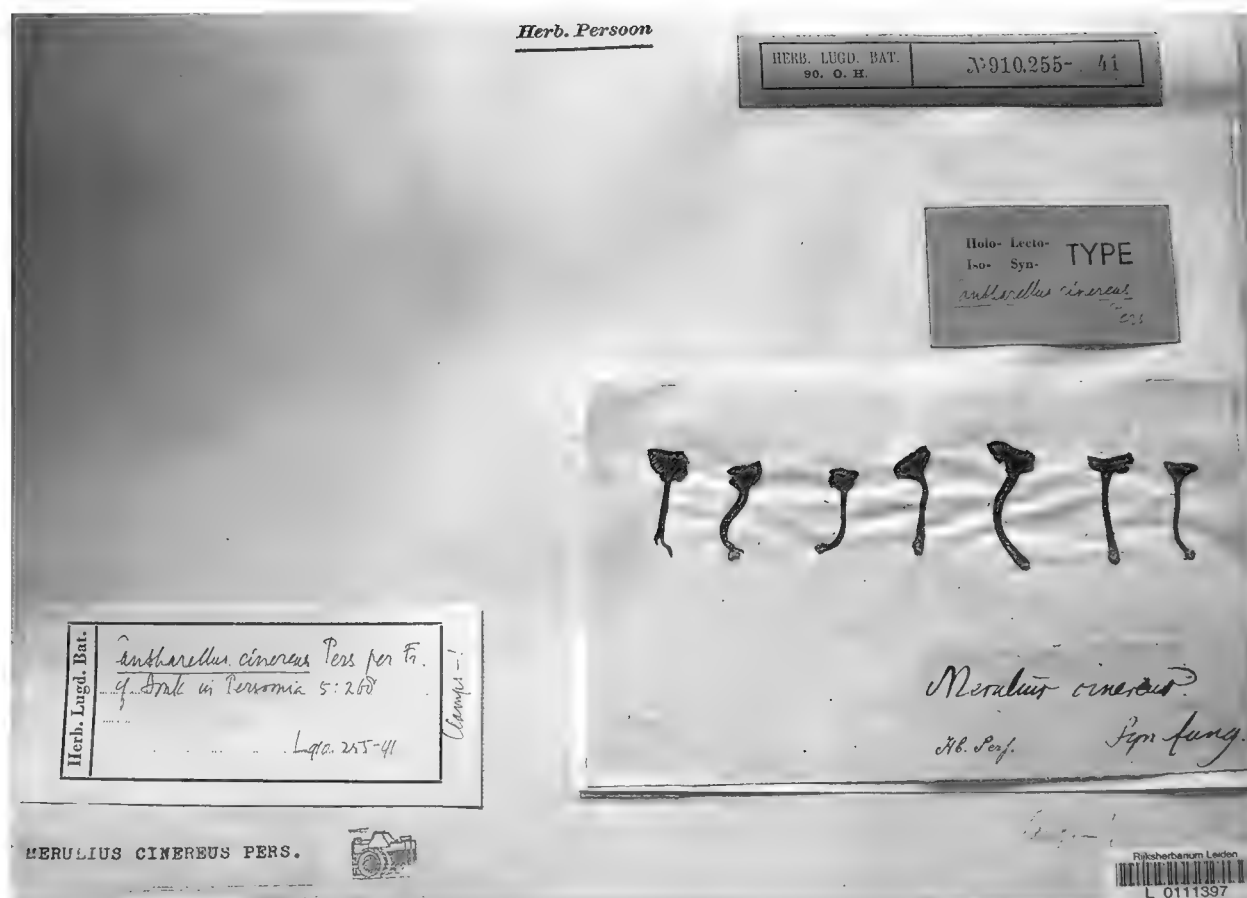
L0111397 (FIG. 1) — This collection is labeled as “type”, although no official designation has been proposed to our knowledge (see also Donk, 1969). Here we designate L0111397 as “neotype” because evidence is lacking that it was in Persoon’s hands when the name was published (Persoon 1794). Epitypification is excluded because the original diagnosis lacked drawings and/or reference to other plates.

Micromorphological features are reported in the following section “Neotypification of *Cantharellus cinereus*”.

L0111398 — Basidia 4-spored, 55–65 µm, lacking basal clamps. Subhymenium hyphae without clamps. Spores 9–10 × 5–6 µm. Pileipellis made up of cylindrical hyphae to 10 µm wide, sometimes anastomosed, with occasional secondary septa. Clamp connections lacking in all tissues.

Persoon labeled this collection “*Merulius cinereus*” and also wrote on the herbarium sheet that *Helvella hydrolips* Bull. 1790 was the same taxon.

There’s also a short note by Bas, date XII.1968: “Hymenium on fold near margin of cap. Basidia without clamps!”

FIGURE 1. *Craterellus cinereus* (neotype).

Lo111399 — Basidia 4-spored, on average 55 μm long, lacking basal clamps. Subhymenium hyphae without clamps. Spores 9–11 \times 5.5–6.5 μm . Pileipellis made up of cylindrical hyphae; secondary septa present; clamp connections lacking throughout.

In the herbarium sheet are some notes in Persoon's handwriting: 1) the collection represents *Merulius cinereus* Syn. Fung.; 2) specimens sent to Persoon by "Raddi", probably Giuseppe Raddi (1770–1829), a Florentine mycologist known for describing *Boletus rubropunctatus*, an earlier synonym of *Boletus bellinii* Inzenga 1879; 3) probably in Persoon's handwriting, "espèce très rare chez nous".

Lo111400 — Basidia 4-spored, 50–55 μm , lacking basal clamps. Subhymenium hyphae without clamps. Spores 9.5–10 \times 6 μm . Pileipellis made up of cylindrical hyphae to 10 μm wide, secondary septa present (but less numerous than in the other collections). Clamp connections lacking in all tissues.

From the herbarium sheet it seems that this collection, labeled "*Cantharellus cinereus*", was not identified by Persoon but by Leveillé. In fact the name "*Cantharellus cinereus*" is followed by a short note: "Leveillé scrips.". However, also in this case, the microfeatures support it as representing Persoon's "*cinereus*".

Second Folder

L0111401 — Basidia 2- and 4-spored, 70 µm, lacking basal clamps, as in the subhymenium. Spores 9.5–11 × 7–8 µm. Pileipellis made up of cylindrical hyphae to 10 µm wide, secondary septa not seen.

Donk, who studied this collection, ascribed it to “*Pseudocraterellus*.” Based on two-spored basidia and different spore morphology, M. Carbone believes the basidiomata to represent *Craterellus undulatus* (Pers.) Redeuilh 2004.

Neotypification of *Cantharellus cinereus*

Craterellus cinereus (Pers. : Fr.) Donk, Meded. Ned. Mycol. Ver. 22 : 67. 1933, nom. illeg. but see the proposal of conservation by Olariaga et al. (2009).

FIGS. 1, 2

(non *Craterellus cinereus* Pers., Mycol. Europ. 2: 6, 1825).

≡ *Cantharellus cinereus* Pers. : Fr., Neues Mag. Bot. 1: 106. 1794.

≡ *Merulius cinereus* (Pers. : Fr.) Pers., Icon. Descr. Fung. 1: 10, tab. 3, fig. 3. 1798.

≡ *Xerocarpus cinereus* (Pers. : Fr.) P. Karst., Rev. Mycol. (Toulouse) 3(9): 22. 1881.

≡ *Pseudocraterellus cinereus* (Pers. : Fr.) Kalamees, Tartu Riik. Ülik. Toim. 136: 90. 1963.

NEOTYPUS HIC DESIGNATUS: “L0111397 = 910.255-41, *Merulius cinereus* Pers.” (L).

We designate this collection as neotype of *Cantharellus cinereus* Pers. 1794, following and agreeing with Donk (1969), who was the first to select it as “type” although not formally and not in a printed publication (see the packet in L).

The seven small basidiomata are in good state of conservation and are mature enough for microscopical studies (FIG. 1).

Donk’s reference (1969) to number 910.255-14 was surely a misprint. His description perfectly fits 910.255-41.

Macroscopic features

As originally indicated by Persoon (1794, 1801, 1825).

Microscopic features

BASIDIA 4(–5)-spored, 55–60 µm long, without basal clamps. SUBHYMENIUM HYPHAE without clamps. SPORES 9–10 × 5–6 µm (FIG. 2D). PILEIPELLIS made up of cylindrical hyphae up to 10 µm wide, secondary septa present (FIG. 2B). CLAMP CONNECTIONS lacking in all tissues.

After revision of Persoon’s material, including the collection here designated as neotype, it is clear that for “*Cantharellus cinereus*”, i.e. *Craterellus cinereus*, Persoon meant an unclamped species with spores never exceeding 11 µm long.

Consequently, the original concept of the taxon “*cinereus*” conforms to the one adopted by most authors who studied the species giving detailed descriptions also from a micromorphological point of view.



FIGURE 2. *Craterellus cinereus*.

A. Fresh basidiomes in situ. B–D. Neotype. B. Pileipellis. C. Basidiomes. D. Spores.

Bars: A = 3 cm; B, D = 10 μ m; C = 1 cm.

Proposal of a new species

For the reasons given above, the taxon exhibiting clamp connections and described as “*Cantharellus cinereus*” by Corner (1966), Jülich (1989), Ellis & Ellis (1990), and Romagnesi (1995) does represent a different species without an available and eligible valid name, so the introduction of a new species is necessary. We consider this species to represent not a *Craterellus* but a true *Cantharellus* characterized by a non-perforate pileus, well developed, cantharelloid gill-folds (Corner 1966), and a fibrous, solid stipe.

***Cantharellus atrofuscus* Contu, Vizzini, M. Carbone & Setti, sp. nov.**

FIG. 3

MYCOBANK MB513350

MISAPPLIED: “*Cantharellus cinereus*” sensu Corner (1966), Jülich (1989), Ellis & Ellis (1990), Romagnesi (1995); non *Cantharellus cinereus* Pers. 1794.

*Basidiomata usque ad 70 mm alta, caespitosa, simplicia, haud pluripileata. Pileus 10–80 mm latus, modice carnosus, depressus vel infundibuliformis sed haud perforatus, reflexus ad expansum, minute fibrillosus, niger vel atrofuscus deinde ochraceo-griseus. Hymenium venosum, ex plicis pseudolamellaribus griseis, saepe intervenosis vel anastomosis, obtusis efformatum. Stipes 30–70 × 3–10 mm, cylindraceus, haud compressus, versus basim albidus vel flavidus, aliunde concolor cum pileo, levis, solidus, subplenus vel fibroso-plenus. Caro modice conspicua, pallide griseo-brunnea, immutabilis. Odor ut in *Muscari racemosa*; sapor mitis. Sporae 9.4–10.5 × 8.3–9.4 µm, hyalinae, regulariter ellipsoideae, late ellipsoideae, obtusae, pluriguttulatae, parietibus leviter incrassatis. Basidia 57–83 × 9.8–13 µm, tetraspora, clavata, fibulata. Pilei cutis ex hyphis cylindraceis ad apicem angustatis, 4.5–12.5 µm, latis constituta, pigmento intraparietali et vacuolari. Septa secundaria rara vel nulla. Fibulae numerosae.*

Hab.: ad terram, in silvis. Autumno-hieme. Typus: Italia, Sardegna, prov. Sassari, Tempio Pausania, loc. Baldo, in nemore frondoso acido cum Quercu subere, 26.10.2002, leg. G. Consiglio (Erbario AMB, n. 1, holotypus).

PILEUS 10–80 mm, thin-fleshed, largely depressed but with solid flesh, not appreciably perforate in old specimens, very undulate, deep anthracite black, somewhat discolored to pale grey-brownish in age; SURFACE typically with long and thick radial fibrils, slightly darker than the background color, margin often lobed (FIG. 3A). Black with KOH. HYMENIUM with well formed and relatively thick gill-like folds, forked and interveined, slightly decurrent to decurrent, ash grey, gill-fold edges blunt. STEM 30–70 × 3–10 mm, fibrous and solid for a long time, sub-hollow only in some overmature specimens, mainly clavate, dry, with long and thick longitudinal fibrils, concolorous with pileus, white to yellow toward the base. CONTEXT quite firm, pale brownish grey, unchanging. SMELL fruity [reminiscent of *Muscari racemosum* (L.) Mill.], quite pleasant. TASTE mild. SPORE-PRINT white.

SPORES 9.4–10.5 × 8.3–9.4 µm, Q = 1.08–1.18, Qm = 1.13, Vm = 412 µm³, subglobulose to widely ellipsoid, with non-refractive granular contents, inamyloid, smooth (FIG. 3D). BASIDIA 57–83 × 9.8–13 µm, (2–)4-spored, narrowly clavate; sterigmata up to 8 µm long, slightly curved inward (FIG. 3C). HYMENOPHORAL TRAMA irregular, made up of hyphae to 20 µm wide, hyalinae in L4 mounts, yellow in Melzer reagent. PILEIPELLIS a cutis of hyphae variously twisted, up to 12.5 µm wide, not gelatinized, yellow in Melzer reagent, smooth, cylindrical; terminal elements smooth, to 6 µm wide, with more or less cream-colored intracellular pigment, some with a very thin incrusting pigment (FIG. 3B). TRAMAL HYPHAE cylindrical, up to 10 µm wide. STIPE HYPHAE cylindrical, in medulla 8 µm diam., in cortex 5 µm diam, smooth, yellow in Melzer, terminal elements smooth. CLAMP CONNECTIONS present in all tissues.

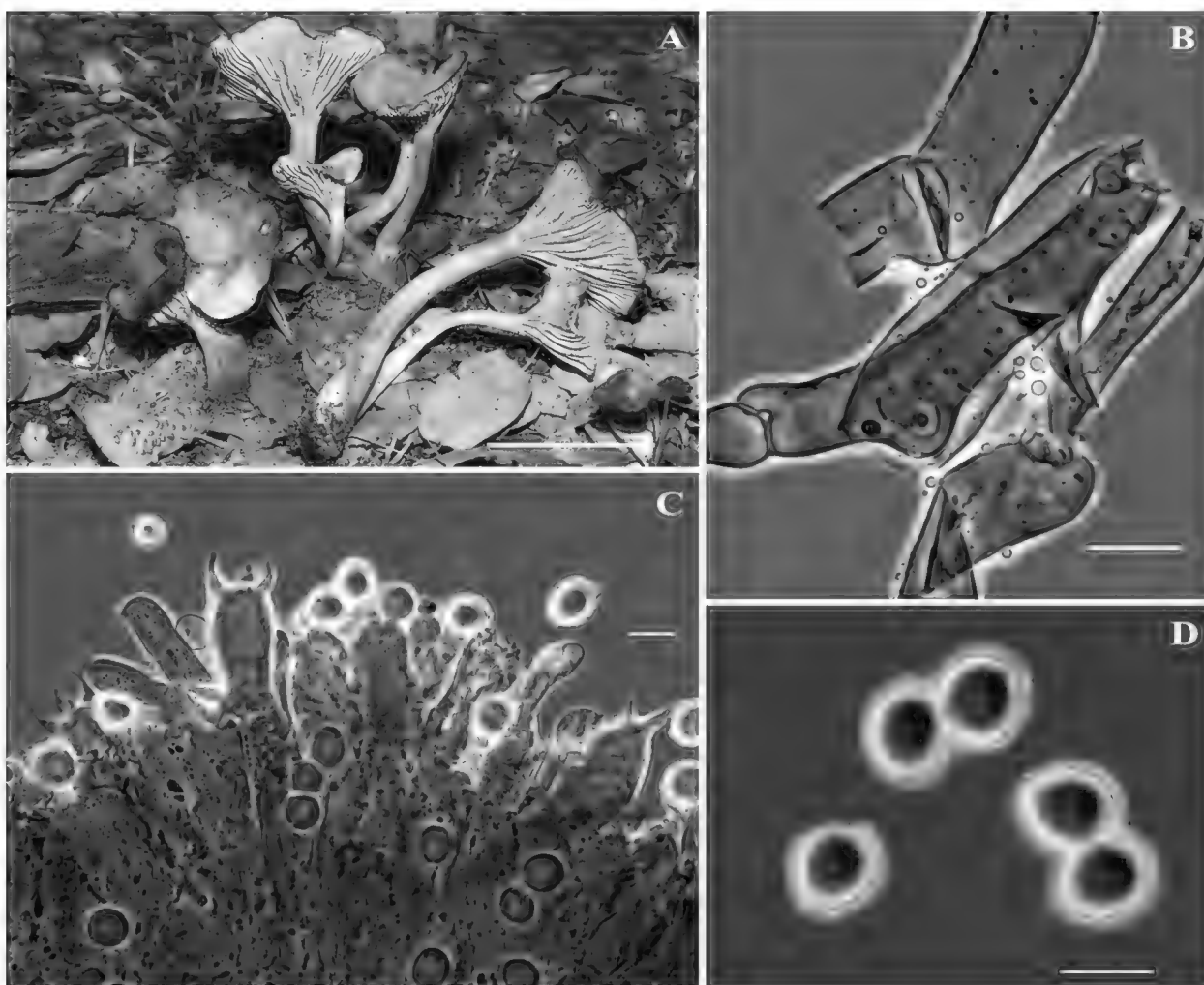


FIGURE 3. *Cantharellus atrofuscus* (holotype).
A. Fresh basidiomes in situ. B. Pileipellis. C. Hymenium. D. Spores.
Bars: A = 5 cm; B, C, D = 10 μ m.

HABITAT: cespitose, both in hardwood and conifer or also mixed forests. In autumn and winter.

DISTRIBUTION: so far surely known from France and Italy, but probably more widespread, due to the confusion with *C. cinereus*.

ADDITIONAL MATERIAL STUDIED. ITALY: Sardinia, prov. Sassari, Monte Limbara, loc. S'Ampulla, under *Quercus ilex* L., 25.10.2002, leg. M. Contu (CAG); ibidem, prov. Nuoro, Villagrande, loc. Bosco di S. Barbara di Villagrande, 27.10.1999, leg. F. Padovan e M. Floriani (studied but not conserved).

Discussion

Based on molecular studies by Feibelman et al. (1997) and Dahlman et al. (2000), delimitation of the cantharelloid genera has undergone many changes. Those studies established that *Cantharellus* s. str. must be limited to the *Cantharellus cibarius* complex (for an actual definition of the genus cfr. Eyssartier & Buyck 2000), while *Pseudocraterellus* Corner must be included in *Craterellus* (Feibelman et al. 1997, Dahlman et al. 2000, Moncalvo et al.

2006). For that reason *Craterellus* should include species with funnel-shaped basidiomes, with (completely or partly) hollow stipes and with or without clamps (sect. *Leptocantharellus* Peck included). Placement of our new species within *Cantharellus* is supported by the presence of a solid stipe and a non-funnel-shaped pileus as in the *Cantharellus cibarius* complex.

As shown above, *Cantharellus atrofuscus* has often been confused with *Craterellus cinereus*, from which it differs in the following features (TABLE 1): 1) pileus depressed but almost never perforate in mature specimens; 2) gill-like folds better defined, thicker, and with a sharp edge; 3) smell strong, fruity and not weak or aromatic; 4) larger and more rounded spores; 5) abundant clamp connections on basidiome hyphae in which secondary septa are rare or absent, whilst they are abundant in the hyphae of *C. cinereus*.

Macroscopical differences are not always easy to ascertain in the field, so microscopical studies are required to make a correct identification. The stipe morphology could help differentiate fresh, well formed basidiomata of both species: in *Craterellus cinereus* it is always hollow from the young stages whilst it is always fibrous and solid to sub-hollow in *Cantharellus atrofuscus*.

While *C. cinereus* could be confused with many species (Singer 1963, Corner 1966, Petersen 1969, Bigelow 1978, Grgurinovic 1997), on the contrary *Cantharellus atrofuscus*, once surely identified, can be confused with very few. The similar *Cantharellus congolensis* Beeli 1928 differs in more crowded gill-like folds, flesh that discolours from red to black, lack of odor, smaller ($5.3\text{--}7.3 \times 3.9\text{--}4.7 \mu\text{m}$) spores, and the pseudoparenchymatic structure of subhymenium and stipe trama (Heinemann 1958).

Craterellus cornucopioides (L.) Pers. 1825 (*C. fallax* A.H. Sm. 1968 included, see Dahlman et al. 2000) differs in producing a deeply funnel-shaped, hollow basidiome, a quite smooth hymenophore, hyphae without clamps, predominantly 2-spored basidia, and bigger ($10\text{--}14 \times 8\text{--}11 \mu\text{m}$) spores (e.g. Knudsen et al. 1997).

Craterellus melanoxeros (Desm.) Pérez-De-Greg. 2000 is easily distinguished by the long-lasting yellow coloration, white flesh, non-fruity smell, narrower spores, and different pileus cuticle structure (Neville & Alpago-Novello 1998).

Among North American taxa, *Craterellus venosus* R.H. Petersen (Petersen 1975) differs in having a perforate basidiome, hyphae without clamp connections, strictly 6-spored basidia, and narrower ($8.1\text{--}10 \times 4.8\text{--}5.6 \mu\text{m}$) spores, while *Craterellus caeruleofuscus* A.H. Sm. (Smith 1968, Bigelow 1978) is characterized by a perforate basidiome, a glabrous pileus, a venose hymenophore, hyphae without clamp connections, 6-(rarely 2-)spored basidia, and smaller ($7\text{--}8.5\text{--}(9) \times 5\text{--}6\text{--}(6.5) \mu\text{m}$) spores.

TABLE 1. Main distinguishing characters between *Craterellus cinereus* and *Cantharellus atrofuscus*

SPECIES	BASIDIOMES	GILL-LIKE FOLDS	BASIDIOSPORES	HYPHAE
<i>C. cinereus</i>	Pileus and stipe perforated (“cornucopioid”)	Sharp edged	9–10 × 5–6 µm, narrowly ellipsoid	Clamp connections absent; secondary septa abundant
<i>C. atrofuscus</i>	Pileus and stipe not perforated	Blunt edged	9.4–10.5 × 8.3–9.4 µm, subglobose to broadly ellipsoid	Clamp connections present; secondary septa rare

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Literature cited

Bigelow H. 1978. The cantharelloid fungi of New England and adjacent areas. *Mycologia* 70(4): 707–756.

Breitenbach J, Kränzlin F. 1986. Champignons de Suisse. Champignons sans lames. 2. Lucerne.

Corner EJH. 1966. A monograph of cantharelloid fungi. *Ann. Bot. Mem.* 2: 1–255. London.

Dahlman M, Danell E, Spatafora JW. 2000. Molecular systematics of *Craterellus*: cladistic analysis of nuclear LSU rDNA sequence data. *Mycological Research* 104(4): 388–394.

Donk MA. 1969. Notes on *Cantharellus* Sect. *Leptocantharellus*. *Persoonia* 5: 265–284.

Ellis MB, Ellis JP. 1990. Fungi without gills (*Hymenomycetes* and *Gasteromycetes*). An identification handbook. Chapman and Hall.

Eyssartier G, Buyck B. 2000. Le genre *Cantharellus* en Europe. *Nomenclature et taxonomie*. *Bull. Soc. Mycol. Fr.* 116(2): 91–137.

Feibelman TP, Dojdrick ML, Cibula WG, Bennett JW. 1997. Phylogenetic relationships within the *Cantharellaceae* inferred from sequence analysis of the nuclear large subunit rDNA. *Mycol. Res.* 101: 1423–1430.

Grgurinovic CA. 1997. Larger fungi of southern Australia. Perth.

Heinemann P. 1958. Champignons récoltés au Congo Belge par Madame M. Goossens-Fontana. III. *Cantharellinae*. *Bull. Jard. Bot. Etat (Bruxelles)* 28(4): 385–438.

Index Fungorum (CABI databases) - Authors of Fungal Names website. <http://www.indexfungorum.org/Names/AuthorsOfFungalNames.asp>

IPNI Authors website. <http://www.ipni.org/>.

Jülich W. 1989. Guida alla determinazione dei funghi. 2. Trento.

- Knudsen H, Persson O, Hansen EB. 1997. *Cantharellaceae* J. Schröt. In: Hansen L, Knudsen H. Nordic macromycetes. Vol. 3. Heterobasidioid, aphylophoroid and gastromycetoid Basidiomycetes. Nordsvamp, Copenhagen. pp. 260–263.
- Kühner R, Romagnesi H. 1953. Flore analytique des champignons supérieurs. Paris.
- Lundell S, Nannfeldt JA. 1949. Fungi Exsiccati Suecici, Praesertim Upsaliensis. Fasc. 35–36. Uppsala, Sweden.
- Marchand A. 1973. Champignons du nord et du midi. 2. Perpignan.
- Moncalvo JM, Nilsson RH, Koster B, Dunham SM, Bernauer T, Matheny PB, Porter TM, Margaritescu S, Weiss M, Garnica S, Danell E, Langer G, Langer E, Larsson E, Larsson KH, Vilgalys R. 2006. The cantharelloid clade: dealing with incongruent gene trees and phylogenetic reconstruction methods. *Mycologia* 98(6): 937–948.
- Neville P, Alpago-Novello L. 1998. Deux taxons souvent confus à tort, *Cantharellus melanoxeros* Desm et *C. ianthinoxanthus* (Maire) Kühner. *Bull. Soc. mycol. Fr.* 114(4): 1–28.
- Olariaga I, Salcedo I, Parra LA. 2009. (1863) Proposal to conserve the name *Craterellus cinereus* (Pers. : Fr.) Donk with a conserved type against *Craterellus cinereus* Pers. (*Basidiomycota*). *Taxon* 58(1): 294–295.
- Pegler DN, Roberts PJ, Spooner BM. 1997. British chanterelles and tooth fungi. Kew.
- Persoon CH. 1794. Neuer Versuch einer systematischen Eintheilung der Schwämme. Roemer's Neues Magazin für die Botanik 1: 63–128.
- Persoon CH. 1801. Synopsis methodica fungorum.
- Persoon CH. 1825. Mycologia europaea. Vol. 2. Palmius JJ. Erlangae.
- Persson O, Mossberg B. 1994. Kantereller. Stockholm.
- Persson O, Mossberg B. 1998. The chanterelle book. Stockholm.
- Petersen RH. 1969. Notes on cantharelloid fungi. II. Some new taxa and notes on *Pseudocraterellus*. *Persoonia* 5(3): 211–223.
- Petersen RH. 1975. Notes on cantharelloid fungi. VI. New species of *Craterellus* and infrageneric rearrangement. *Ceská Mykologie* 29: 199–204.
- Romagnesi H. 1995. Prodrome à une Flore Analytique des Hyménomycètes agaricoïdes. III. Fam. *Cantharellaceae*. *Doc. Mycol.* 25(98–100): 417–424.
- Singer R. 1963. Oak mycorrhiza fungi in Colombia. *Mycopathologia, Mycologia Applicata* 20(3–4): 239–252.
- Smith AH. 1968. The *Cantharellaceae* of Michigan. *Michigan Bot.* 7: 143–183.
- Watling R, Gregory N. 1998. British fungus flora. 8. Edinburgh.

The sabulicolous fungi from Sicily (southern Italy): additions and critical review

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Abstract — The ecological and distributive data on 165 sabulicolous taxa (29 *Ascomycetes* and 136 *Basidiomycetes* representing 89 genera and 48 families) collected from Sicily in southern Italy are reported. New additions are cited, and data reported in literature for the Sicilian territory is critically reviewed. The full checklist is available on

<http://www.mycotaxon.com/resources/weblists.html>

Key words — distribution, ecology, arenicolous fungi

Introduction

The wide literature on fungi growing on sandy dunes (cfr. the complete list reported in the full checklist on the Mycotaxon web site) were checked with particular reference to the Italian territory and integrated with new data arising from field excursions carried out by authors in Sicily (southern Italy). The aim was to critically analyze the data reported in literature and to draw up an exhaustive picture of sabulicolous fungi growing in Sicily.

Materials and methods

Data on recorded taxa are referred to habitat, collection localities, and cartographic reference; notes pertain only to taxa in found sandy environments and not to the general distribution in Sicily. The literature reported by Contu & Signorello (1999) and Signorello & Contu (1999) were also considered, but no critical examinations were made since the cited samples are not kept in the herbaria of Catania (CAT) and Cagliari (CAG). The distributive data were referred to the grid map 1:50.000 of the Official Map of the Italian State (I.G.M.I.), following the methodology proposed by Padovan (1994). Nomenclature was checked according to Index Fungorum (<http://www.indexfungorum.org/Names/Names.asp>). Exsiccata are kept in the Herbarium Mediterraneum of Palermo (PAL), the

Royal Botanic Gardens of Kew (K), the National Botanic Garden of Belgium (BR), and the personal herbarium of the first author (A.L.).

Conclusions

The littorals and sandy dune areas of Sicily have been strongly modified by anthropic pressure, fragmentation into lots for tourist villages and residences, and reforestation. Nevertheless the coastal belts still host interesting plant and fungal species. The reported number of macromycetes is 35 taxa (14 *Ascomycetes* and 21 *Basidiomycetes*) collected on embryo dunes, high dunes, rear dunes, and consolidated dunes and 114 taxa (12 *Ascomycetes* and 102 *Basidiomycetes*) from reforested consolidated dunes. Fungi with uncertain habitats correspond to 14 taxa (3 *Ascomycetes* and 11 *Basidiomycetes*). Two *Basidiomycetes* were excluded from the sabuliculous environment since they grow in a strongly anthropized area. 165 taxa (29 *Ascomycetes* and 136 *Basidiomycetes*) representing 160 species and 5 varieties were reported. As shown in FIG. 1, saprobes comprise the main ecological category (119 taxa), followed by mycorrhizal (33) and parasitic (13) taxa. According to substrate (Fig. 2), there are 111 terricolous, 24 lignicolous, 20 debris, and 10 bryophilous fungal taxa.

Embryo dunes, which are exposed to high winds and salt, host only few fungi species. On higher dunes, where the vegetation was substituted by *Medicagini marinae*-*Ammophiletum australis* and characterized by big tufts of *Ammophila australis*, *Peziza ammophila* Durieu & Mont. 1846 is one of first to appear at the end of November with a progressive increase of fructification in the following months. *Agaricus aridicola* Geml et al. 2004, *A. menieri* Bon 1981, *Hebeloma ammophilum* Bohus 1978, *Inocybe serotina* Peck 1904, *Lepiota brunneolilacea* Bon & Boiffard 1972, *Marasmius anomalus* Lasch ex Rabenh. 1854, *Panaeolus cinctulus* (Bolton) Britzelm. 1883, *Peziza ammophila*, *P. pseudoammophila* Bon ex Donadini 1978 and *Rhodocybe malenconii* Pacioni & Lalli 1985 were observed fruiting close to *A. australis*. *Agaricus aridicola*, *Panaeolus cinctulus*, *Peziza ammophila*, *P. pseudoammophila* and *R. malenconii* are considered strictly arenicolous species with a wide spectrum of diffusion. In the level stretch of rear dunes *Centaureo-Ononidietum ramosissimae* associates with only a few species such as *Arrhenia spathulata* (Fr.) Redhead 1984, *Galerina laevis* (Pers.) Singer 1961, and *Peziza boltonii* Quél. 1879. In the consolidated dunes a very interesting psammophilous maquis is observed. The plant association is mainly represented by *Juniperus macrocarpa* that is located on coastal dunes belonging to the *Ephedro fragilis-Juniperetum macrocarpae*. Due to wave action this plant association occupies a belt very close to the seashore. A huge number of fungi such as *Arrhenia spathulata*, *Agaricus devoniensis* P.D. Orton 1960, *Conocybe filaris* (Fr.) Kühner 1935, *Geopora arenicola* (Lév.) Kers 1974, *G. arenosa* (Fuckel) S. Ahmad 1978, *Hymenoscyphus conscriptus*

(P. Karst.) Korf ex Kobayasi et al. 1967, *Marasmiellus trabutii* (Maire) Singer 1951, *Pithya cupressi* (Batsch) Fuckel 1870, *Smardaea planchonis* (Dunal ex Boud.) Korf & W.Y. Zhuang 1991, and *Xerula mediterranea* (Pacioni & Lalli) Quadr. & Lunghini 1990 grows close to the shrubs. In consolidated dunes within the investigated coastal region, reforested areas are found that generate a protective windbreak against salt. The coastal natural vegetation has been replaced by alien plants such as *Acacia saligna*, *Pinus pinea*, *P. halepensis*, *P. pinaster*, and *Eucalyptus camaldulensis* that negatively affect the environment and impede a natural plant succession. Fungi are the most abundant in such areas, and rare or infrequent taxa were observed, such as *Agaricus chionodermus* Pilát 1951, *A. gennadii* (Chatin & Boud.) P.D. Orton 1960, *A. langei* (F.H. Møller & Jul. Schäff.) Maire 1952, *A. lanipes* (F.H. Møller & Jul. Schäff.) Singer 1949, *Battarrea phalloides* (Dicks.) Pers. 1801, *Parasola megasperma* (P.D. Orton) Redhead et al. 2001, *Cortinarius bisporiger* Contu 1992, *Crepidotus calolepis* (Fr.) P. Karst. 1879, *Descomyces albus* (Berk.) Bougher & Castellano 1993, *Geastrum schmidelii* Vittad. 1842, *Inocybe arenicola* (R. Heim) Bon 1983, *I. dulcamara* (Alb. & Schwein.) P. Kumm. 1871, *I. dunensis* P.D. Orton 1960, *I. heimii* Bon 1984, *I. rufuloides* Bon 1984, *Lactarius hepaticus* Plowr. 1905, *Lamprospora crouanii* (Cooke) Seaver 1914, *Leucoagaricus menieri* (Sacc.) Singer 1968, *L. pilatianus* (Demoulin) Bon & Boiffard 1976, *L. salmoneophyllus* Bon & Guinb. 1993, *L. wichanskyi* (Pilát) Bon & Boiffard 1974, *Limacella illinita* (Fr.) Maire 1933, *L. subfurnacea* Contu 1990, *Lyophyllum buxum* (Maire) Singer 1943, *L. littoralis* (Ballero & Contu) Contu 1998, *Marasmius corbariensis* (Roum.) Sacc. & Trotter 1911, *Melanoleuca tristis* M.M. Moser 1991, *Omphalina galericolor* (Romagn.) M.M. Moser 1975 var. *galericolor*, and *Psathyrella melanthinia* (Fr.) Kits van Wav. 1985. The presence of *L. buxum*, a rare Mediterranean species, is noteworthy and within in Italy confined to Sicily (Contu & Signorello 1999, Signorello & Contu 1998, Contu & La Rocca 1999, La Rocca & Bazan 2001, Lantieri 2003) and Sardinia (Contu & La Rocca 1999).

Other taxa that are not included in any vegetational belts but are rare or previously unreported include *Leucoagaricus singeri* (Bon ex Contu & Signor.) Cons. & Contu 2004, *Trametes ljubarskyi* Pilát 1937, and *Xerula xeruloides* (Bon) Dörfelt 1980. The presence of hypogeous or semi-hypogeous fungi — *Descomyces albus*, *Hydnangium carneum* Wallr. 1839, *Hysterangium inflatum* Rodway 1918, *Reddellomyces donkii* (Malençon) Trappe et al. 1992, *Pisolithus arhizus* (Scop.) Rauschert 1959, *Setchelliogaster tenuipes* (Setch.) Pouzar 1958 — is not strictly linked to *E. camaldulensis* but also to *A. saligna*. Apart from the basidiomycete *Arrhenia rickenii* (Hora) Watling 1989, moss-associated species (6 parasites, 4 saprophytes) belong to *Ascomycetes*. Some are rare (e.g., *Ciboria polygoni-vivipari* Eckblad 1969, *Lamprospora dictydiola* Boud. 1907, *Octospora convexula* (Pers.) L.R. Batra 1963) while others are uncommon (e.g., *L. crouanii*,

Octospora humosa (Fr.) Dennis 1960, *O. leucoloma* Hedw. 1789). *Pustularia patavina* (Cooke & Sacc.) Boud. 1907, a very uncommon species reported from Italy in Tuscany (Franchi et al. 2001) and Sicily (La Rocca & Bazan 2001, Lantieri 2004), is noteworthy. A huge number of lignicolous species were collected from stumps, rot roots, and other plant residues deposited on the beach. Among the limited fungi that grow on burnt areas are the strictly anthracophilous *Anthracobia melaloma* (Alb. & Schwein.) Arnould 1893, *Panaeolus guttulatus* Bres. 1881, *Peziza violacea* Pers. 1794 and *Plicaria endocarpoides* (Berk.) Rifai 1968.

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Literature cited

- Contu M, La Rocca S. 1999. Entità micologiche rare o interessanti della zona mediterranea insulare italiana. *Fungi Nondum Delineati* 9: 1–48.
- Contu M, Signorello P. 1999. Contributo alla conoscenza della flora micologica (Macromiceti) delle dune della Sicilia. *Boll. Accad. Gioenia Sci. Nat. Catania* 32(356): 31–45.
- Franchi P, Gorreri L, Marchetti M, Monti G. 2001. I funghi di ambienti dunali. Ente Parco Regionale Migliarino San Rossore.
- Lantieri A. 2003. Funghi interessanti o rari dei litorali sabbiosi della Sicilia sud-orientale (2° contributo). *Boll. Circolo Micologico G. Carini* 46: 37–48.
- Lantieri A. 2004. Funghi interessanti o rari dei litorali sabbiosi della Sicilia sud-orientale (3° contributo). *Boll. Gruppo Micol. "G. Bresadola"* 47(1): 37–46.
- La Rocca S, Bazan G. 2001. Contributo alla conoscenza della micoflora delle dune costiere della Sicilia: i macromiceti di contrada "Le Macchie" (Balestrate, Palermo). *Quad. Bot. Amb. Appl.* 12: 3–12.
- Padovan F. 1994. Mappatura dei macromiceti in Italia (Problemi cartografici). *Rivista Micol.* 37(1): 59–69.
- Signorello P, Contu M. 1998. Macromiceti interessanti e nuovi dalla Sicilia. *Micol. Veg. Medit.* 13(1): 59–68.
- Signorello P, Contu M. 1999. Macromiceti della Sicilia. Sesto contributo. *Boll. Accad. Gioenia Sci. Nat. Catania* 32(356): 47–52.

Additions to the lichen biota of Iran

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Abstract — *Lepraria caesioalba* (chemotype III), *L. rigidula*, and *Ochrolechia turneri* are reported as new to Iran. The record of *O. turneri* is the first for Asia and the genus *Ochrolechia* is reported from Iran for the first time. All taxa are characterized, and notes on the distribution, ecology, and differentiation from similar species are provided. Further records of the under-collected species *L. vouauxii* are also presented.

Key words — lichen substances, neglected habitats, sterile lichens

Introduction

The lichen biota of Iran has been recently subjected to considerable lichenological activity, resulting in several publications (Hadji Moniry et al. 2005, Sohrabi & Alstrup 2007, Sohrabi & Sipman 2007, Kukwa & Sohrabi 2008), and the compilation of two checklists (Seaward et al. 2004, 2008). To date, 646 species of lichens, lichenicolous, and allied fungi have been reported from the country (Seaward et al. 2008, Kukwa & Sohrabi 2008), and a comparison between the checklists shows that 243 taxa have been added in a period of only four years. This suggests that the number of species in Iran is still under-estimated and many additional taxa can be expected.

During the revision of lichens collected by the first author, three species identified have never been reported from Iran; these are all sorediate, permanently or commonly sterile, crustose lichens and the least studied generally, since identification and taxonomy are based mainly on secondary chemistry. This paper presents the first localities for two *Lepraria* species, and the first record of the genus *Ochrolechia* from Iran. Brief notes on their morphology, chemistry, distribution, and ecology for each species, as well as on similar taxa, are provided.

Material and methods

Studied material is deposited in UGDA and the the private herbarium of MHM. Comparative specimens studied are housed in BM, E and UGDA. Morphology was studied using a stereomicroscope. Chemical analyses were carried out by thin layer chromatography (TLC) in solvent systems A and C according to the methods of Orange et al. (2001).

The taxa

Lepraria caesioalba (B. de Lesd.) J.R. Laundon, Lichenologist 24: 324. 1992.

≡ *Crocynia caesioalba* B. de Lesd., Bull. Soc. Bot. France 61: 84. 1914.

MORPHOLOGY: The thallus is typical for members of the *Lepraria neglecta* group: grey, often with a bluish tinge, thick, with diffuse or obscurely lobate margin and consisting of coarse granules (see also Tønsberg 1992, 2004; Sipman 2004, Flakus & Kukwa 2007).

CHEMISTRY: *Lepraria caesioalba* is chemically variable: 3 to 5 chemotypes differing in depsidone and/or fatty acid composition have been distinguished (Laundon 1992, Leuckert et al. 1995, Tønsberg 2004). TLC of the Iranian specimen revealed atranorin and psoromic acid; thus it belongs to chemotype 3 according to Leuckert et al. (1995), and is similar to chemotype 5 distinguished by Tønsberg (2004). Leuckert et al. (1995) occasionally detected angardianic/roccellic and 2'-O-demethylpsoromic acids in addition to psoromic acid, and Tønsberg (2004) and Kukwa (2006) reported also rangiformic acid. These substances were not found in the Iranian specimen. Thallus P+ lemon yellow, K+ yellow.

ECOLOGY — *Lepraria caesioalba* grows on soil, rocks, tree bark or mosses (Laundon 1992, Tønsberg 1992, 2004; Sipman 2004, Flakus & Kukwa 2007, Saag et al. 2009). The specimen reported here was found on soil and mosses.

DISTRIBUTION — The species is very widespread, being found in areas with a cool climate on all continents except Africa and Antarctica (Laundon 1992, Tønsberg 1992, 2004; Sipman 2004, Flakus & Kukwa 2007, Saag et al. 2009). Here it is reported as new to Iran.

SPECIMEN EXAMINED—**IRAN. NORTHERN KHORASAN:** 75 km from Bojnourd, Darkesh Reserved Region (37°24'–37°27'N, 56°41'–56°49'E), Nargesli, alt. 2550 m, on mosses and soil—31.3.2009, M. Haji Moniri 2417 (herb. Haji Moniri).

REFERENCE MATERIAL EXAMINED—**FRANCE. SEINE-ET-MARNE:** Forêt de Fontainebeau, on mosses and other lichens—July 1913, M. Bouly de Lesdain (**HOLOTYPE**-E; TLC by J.R. Laundon: atranorin, fumarprotocetraric acid, roccellic acid).

COMMENTS — *Lepraria caesioalba* and the related taxa, *L. alpina* (B. de Lesd.) Tretiach & Baruffo 2006, *L. borealis* Loht. & Tønsberg 1994, *L. granulata* Slav.-Bay. 2007, *L. neglecta* (Nyl.) Erichsen 1957, and *L. zeorinica* (L. Saag) Kukwa

2009, form the so-called *Lepraria neglecta* group. All these species grow in rain-exposed habitats; their thallus has a diffuse to obscurely lobate margin and consists of coarse granules. Members of the group are superficially almost indistinguishable, but they are identifiable on the basis of different secondary lichen substances. Among them, *L. caesioalba* can be easily recognized, as it is the only species of the group producing depsidones, fumarprotocetraric, psoromic or stictic acid, all often accompanied by biosynthetically related metabolites (Tønsberg 2004, Kukwa 2006, Slavíková-Bayerová & Fehrer 2007, Flakus & Kukwa 2007, Fehrer et al. 2008, Kukwa & Flakus 2009, Saag et al. 2009).

Recently, three specimens of *L. caesioalba* varying in depsidone content have been included in molecular studies, and the species appeared to be polyphyletic. The specimen containing psoromic acid forms a well supported group together with the fumarprotocetraric acid chemotype (Ekman & Tønsberg 2002); the last one is believed to represent *L. caesioalba* s.str., as the holotype also contains fumarprotocetraric acid (see Laundon 1992). The specimen with stictic acid is distantly related to both other specimens (Ekman & Tønsberg 2002). Perhaps all chemotypes deserve species status (Tønsberg 2004). As there is still no nomenclatural segregation, the chemotypes are still treated in *L. caesioalba*.

Lepraria rigidula (B. de Lesd.) Tønsberg, *Sommerfeltia* 14: 205. 1992.

= *Crocynia rigidula* B. de Lesd., in Hue, *Bull. Soc. Bot. France* 71: 331. 1924.

MORPHOLOGY: The thallus is grey, bluish-grey or white-grey, leprose, with diffuse margin. The soredia are fine to coarse, sometimes aggregated into consoredia, with distinct and long (up to c. 100 µm) projecting hyphae on the surface of at least some soredia (see also Tønsberg 1992, 2004, Kukwa 2006, Flakus & Kukwa 2007, Saag et al. 2009).

CHEMISTRY: Atranorin and nephrosteranic acid were detected, which agrees with the results presented by Tønsberg (1992) and Leuckert et al. (1995). Thallus C–, K+ yellow, and P+ yellowish or P–.

ECOLOGY — *Lepraria rigidula* usually grows on bark of deciduous trees, but it has also been reported from a range of substrata, including lichen thalli (Tønsberg 1992, 2004; Flakus & Kukwa 2007, Saag et al. 2009). The specimen reported here was found on epigeic bryophytes.

DISTRIBUTION — The species is very widespread, being reported from Africa, Asia, Antarctica, Europe, and North and South America (Tønsberg 1992, 2004; Kümmerling et al. 1995, Øvtedal & Lewis Smith 2001, Flakus & Kukwa 2007, Saag et al. 2009). In Asia, it is known only from Turkey (Kümmerling et al. 1995, John et al. 2000) and the Russian Arctic (Kukwa & Zhurbenko, unpublished data). Here it is reported as new to Iran.

In the locality presented here, *L. rigidula* was accompanied by *L. vouauxii* (Hue) R.C. Harris 1987, a lichen known only from three localities in Iran (Seaward et al. 2004). During the course of this study, we found additional specimens of this taxon. As the species is still scarcely reported in Asia (including Iran), both new findings are presented below.

SPECIMEN EXAMINED—IRAN. NORTHERN KHORASAN: 75 km from Bojnourd, Darkesh Reserved Region (37°24'–37°27'N, 56°41'–56°49'E), Nargesli, alt. 2550 m, on epigeic bryophytes—31.3.2009, M. Haji Moniri 2418 (herb. Haji Moniri).

REFERENCE MATERIAL EXAMINED—GREAT BRITAIN. SCOTLAND: Pitlochry, by side of River Tummel, over mosses on soil over rocks—June 1914, J. McAndrew (HOLOTYPE-E).

SPECIMENS OF *L. vouauxii* EXAMINED—IRAN. NORTHERN KHORASAN: Darkesh Reserved Region, Nargesli, alt. 2550 m, on epigeic bryophytes—31.3.2009, M. Haji Moniri 2415 & 2416 (herb. Haji Moniri). Ghareaghaj, alt. 1415 m, on mosses and soil—29.3.2005, M. Haji Moniri 1976 (herb. Haji Moniri).

COMMENTS — *Lepraria rigidula* is the only species of the genus containing nephrosteranic acid and is thus very characteristic; a few other taxa also produce fatty acids as diagnostic substances (e.g. *L. borealis*, *L. celata* Slav.-Bay. 2006, *L. granulata*, *L. jackii* Tønsberg 1992 and *L. toensbergiana* Bay. & Kukwa 2005), but all of them have coarser (*L. borealis* and *L. granulata*) or finer (e.g., *L. celata*, *L. jackii*, *L. toensbergiana*) soredia, and all lack nephrosteranic acid (e.g. Tønsberg 1992, Lohtander 1994, Flakus & Kukwa 2007, Fehrer et al. 2008, Saag et al. 2009).

Ochrolechia turneri (Sm.) Hasselrot, Svensk Bot. Tidskr. 39: 130. 1945.

= *Lichen turneri* Sm., Engl. Bot. 12: tab. 857. 1801.

MORPHOLOGY: The thallus of *O. turneri* is usually grey, thin and even, or more rarely thick, and then often folded. The species develops usually ± regular and discrete soralia, which sometimes tend to fuse and form a continuously sorediate crust in the centre of the thallus. The apothecia, absent in the Iranian specimen, are lecanorine with pruinose disc. For a detailed description see Tønsberg (1992) and Kukwa (2008).

CHEMISTRY: Variolaric acid and one of the substances called 'microstictoides unknowns' (in lower Rf classes; for details see Kukwa 2008) were found in the Iranian specimen. Kukwa (2008) also reported alectoronic acid, a trace of atranorin and some additional unidentified compounds as accessory metabolites, and exclusively in apothecia gyrophoric and lecanoric acids. However these substances were not found in the studied material. Thallus cortex C–, K–; soralia C+ yellow, K–.

ECOLOGY — *Ochrolechia turneri* has only been found on tree bark, mostly deciduous, but rarely on conifers (Kukwa 2008 and literature cited therein).

DISTRIBUTION — The species is known almost exclusively from Europe (Kukwa 2008), but Hafellner (1995) reported it also from Africa (Canary Islands). Records from North America and Australia are doubtful (Brodo 1991, Kukwa 2008). Here it is reported as new to Iran, and also for Asia. It is the first species of the genus *Ochrolechia* from Iran.

SPECIMEN EXAMINED—**IRAN. KHORASAN PROVINCE:** 75 km from Bojnourd, Darkesh Reserved Region (37°24'–37°27'N, 56°41'–56°49'E), Nargesli, alt. 2550 m, on bark—31.3.2009, M. Haji Moniri 2426 (herb. Haji Moniri, dupl. UGDA-L-15320).

REFERENCE MATERIAL EXAMINED—**GREAT BRITAIN. ENGLAND:** Norfolk, Coltishall, in a wood, on tree bark—s.datum, D. Turner (**HOLOTYPE**-BM).

COMMENTS — *Ochrolechia turneri* is characterized by its sorediate thallus containing variolaric acid as the major secondary metabolite, ± regular and well delimited soralia (at least at the edge of the thallus), and an epiphytic habitat (Kukwa 2008). The species can be confused with *O. alboflavescens* (Wulfen) Zahlbr. 1927 and *O. microstictoides* Räsänen 1936, as they also produce variolaric acid, and in the case of *O. alboflavescens* the soralia are regularly delimited. Both species, however, contain fatty acids, lichesterinic and protolichesterinic acids (Kukwa 2008). So far, they have not been reported from Iran (see Seaward et al. 2008).

Variolaric acid is also produced in *O. dalmatica* (Erichsen) Boqueras 1999 and *O. gowardii* Brodo 1991, two taxa superficially similar to *O. turneri*. They differ essentially in the production of gyrophoric acid in the soralia and the more restricted distribution range: *O. dalmatica* is known mostly from the Mediterranean, and *O. gowardii* from western North America and Scandinavia (Brodo 1991, Holien 1992, Jonsson 2002, Kukwa 2008).

European material of *O. turneri* has been mistaken for the somewhat morphologically similar *Pertusaria albescens* (Huds.) M. Choisy & Werner 1932, *P. amara* (Ach.) Nyl. 1872 and *P. ophthalmiza* (Nyl.) Nyl. 1865. All these species differ in chemistry: *P. albescens* and *P. ophthalmiza* produce fatty acids, and *P. amara* produces picrolichenic acid as the major secondary metabolite (Hanko 1983, Tønsberg 1992). In Iran, only *P. albescens* and *P. amara* have so far been reported (Seaward et al. 2008).

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Literature cited

- Brodo IM. 1991. Studies in the lichen genus *Ochrolechia*. 2. Corticolous species of North America. *Can. J. Bot.* 69: 733–772.
- Ekman S, Tønsberg T. 2002. Most species of *Lepraria* and *Leproloma* form a monophyletic group closely related to *Stereocaulon*. *Mycol. Res.* 106: 1262–1276.
- Fehrer J, Slavíková-Bayerová Š, Orange A. 2008. Large genetic divergence of new, morphologically similar species of sterile lichens from Europe (*Lepraria*, *Stereocaulaceae*, *Ascomycota*): concordance of DNA sequence data with secondary metabolites. *Cladistics* 24: 443–458.
- Flakus A, Kukwa M. 2007. New species and records of *Lepraria* (*Stereocaulaceae*, lichenized *Ascomycota*) from South America. *Lichenologist* 39: 463–474.
- Hadji Moniri M, Fallahian F, Maassoumi A. 2005. Lichens from the Khorasan Province, Iran. – *Folia Cryptog. Estonica* 41: 55–57.
- Hanko B. 1983. Die Chemotypen der Flechtengattung *Pertusaria* in Europa. *Biblioth. Lichenol.* 19: 1–297.
- Hafellner J. 1995. A new checklist of lichens and lichenicolous fungi of insular Laurimacaronesia including a lichenological bibliography for the area. *Fritschiana* 5: 1–132.
- Holien H. 1992. Some lichen species new to Norway and Sweden. *Graphis Scripta* 4: 69–72.
- John V, Seaward MRD, Beatty JW. 2000. A neglected lichen collection from Turkey: Berkhamsted School Expedition 1971. *Turkish J. Bot.* 24: 239–248.
- Jonsson F. 2002. *Ochrolechia gowardii* new to Sweden. *Graphis Scripta* 13: 58.
- Kukwa M. 2006. The lichen genus *Lepraria* in Poland. *Lichenologist* 38(4): 293–305.
- Kukwa M. 2008. The lichen genus *Ochrolechia* in Poland II. Sorediate taxa with variolaric acid. *Herzogia* 21: 5–24.
- Kukwa M, Flakus A. 2009. *Lepraria glaucosorediata* sp. nov. (*Stereocaulaceae*, lichenized *Ascomycota*) and other interesting records of *Lepraria*. *Mycotaxon* 108: 353–364.
- Kukwa M, Sohrabi M. 2008. *Lepraria impossibilis* new to Asia from Iran. *Graphis Scripta* 20: 33–34.
- Kümmerling H, Leuckert C, Wirth V. 1995. Chemische Flechtenanalysen X. *Lepraria rigidula* (de Lesd.) Tønsberg. *Nova Hedwigia* 60: 233–240.
- Laundon JR. 1992. *Lepraria* in the British Isles. *Lichenologist* 24: 315–350.
- Leuckert C, Kümmerling H, Wirth V. 1995. Chemotaxonomy of *Lepraria* Ach. and *Leproloma* Nyl ex. Crombie, with particular reference to Central Europe. *Biblioth. Lichenol.* 58: 245–259.
- Lohtander K. 1994. The genus *Lepraria* in Finland. *Ann. Bot. Fenn.* 31: 223–231.
- Orange A, James PW, White FJ. 2001. *Microchemical Methods for the Identification of Lichens*. London, British Lichen Society.
- Øvtedal DO, Lewis Smith RI. 2001. *Lichens of Antarctica and South Georgia. A guide to their identification and ecology*. Cambridge, Cambridge University Press.
- Saag L, Saag A, Randlane T. 2009. World survey of the genus *Lepraria* (*Stereocaulaceae*, lichenized *Ascomycota*). *Lichenologist* 41: 25–60.
- Seaward MRD, Sipman HJM, Schultz M, Maassoumi AA, Haji Moniri Anbaran M, Sohrabi M. 2004. A preliminary lichen checklist for Iran. *Willdenowia* 34: 543–576.
- Seaward MRD, Sipman HJM, Sohrabi M. 2008. A revised checklist of lichenized, lichenicolous and allied fungi for Iran. *Sauteria* 15: 459–520.
- Sipman HJM. 2004. Survey of *Lepraria* species with lobed thallus margins in the tropics. *Herzogia* 17: 23–35.

- Slavíková-Bayerová Š, Fehrer J. 2007. New species of the *Lepraria neglecta* group (*Stereocaulaceae*, *Ascomycota*) from Europe. *Lichenologist* 39: 319–327.
- Sohrabi M, Alstrup V. 2007. Additions to the lichen mycota of Iran from East Azerbaijan Province. *Mycotaxon* 100: 145–148 [supplementary data at: <http://www.mycotaxon.com/resources/weblists.html>].
- Sohrabi M, Sipman HJM. 2007. Lichens of Golestan National Park (NE Iran). *Mycol. Balcanica* 4: 87–92.
- Tønsberg T. 1992. The sorediate and isidiate corticolous, crustose lichens in Norway. *Sommerfeltia* 14: 1–331.
- Tønsberg T. 2004. *Lepraria*. 322–329, in TH Nash III, BD Ryan, P Diederich, C Gries, F Bungartz (eds), *Lichen Flora of the Greater Sonoran Desert Region*, Vol. 3. Tempe, Lichens Unlimited, Arizona State University.

Distribution of *Diachea* (*Didymiaceae*, *Myxomycetes*) in the northeastern region of Brazil

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Abstract —In an effort to expand knowledge of the distribution of Neotropical myxobiota, the authors summarize the occurrence of *Diachea bulbilosa*, *D. leucopodia*, and *D. silvaepluvialis* in northeast Brazil based on their own collections made between 1995 and 2008, analysis of additional Brazilian herbarium specimens, and comprehensive bibliographical research. Colonized substrates identified were bark of living trees (corticolous), litter (foliicolous), and dead wood (lignicolous), with the largest populations of the predominant foliicolous specimens found in the Atlantic forest. A map showing the geographical distribution in Northeast Brazil accompanies species descriptions, taxonomic observations, and known distribution for each species. This constitutes first reports for *D. leucopodia* from Rio Grande do Norte state and *D. silvaepluvialis* from Paraíba and Pernambuco states.

Key words — floristic survey, taxonomy, chorology

Introduction

Diachea Fr. has been subject to taxonomic disagreement since the late 19th century, with the genus first assigned to *Trichiacei* (Fries 1825; Martin & Alexopoulos 1969). Gaither & Keller (2004) remark on subsequent transfers to the *Stemonitales* (based on the iridescent peridium and noncalcareous capillitium) or the *Physarales* (emphasizing the calcareous stalk and columella). Based on the biochemical study of melanin extracted from spores of *D. leucopodia*, Kalyanasundaram & Mubarak Ali (1989) concluded that *Diachea* may be regarded as a link that indicates a phylogenetic relationship between the *Physarales* and *Stemonitales*, opinion supported by recent phylogenetic studies

(Fiore-Donno et al. 2005). Within *Physarales*, some authors, such as Lister (1925), Hagelstein (1944), Farr (1974) and Martin et al. (1983), shuffled the genus between *Physaraceae* and *Didymiaceae*. Martin et al. (1983), following Farr (1974), placed *Diachea* in the *Didymiaceae* (*Myxogastromycetidae*) based on plasmodium type, limy stalk, columella and hypothallus, and a stalk structure indicating a subhypothallic method of sporophore development; this position is also adopted in this paper.

Diachea is not a species-rich genus and is currently represented by only 12 species (Lado 2001, Hernandez-Crespo & Lado 2005); this listing includes *D. arboricola*, recently described as a corticolous species with a very distinct type of spore ornamentation and known only from the tree canopy in the Great Smoky Mountains National Park, USA (Keller et al. 2004). It excludes *D. deviata* Nann.-Bremek. & Y. Yamam., which Gaither & Keller (2004) consider an aberrant form of *D. subsessilis* Peck.

The first studies on the Brazilian myxomycete biota (Torrend 1915, 1916) report *D. leucopodia* from the state of Bahia (Northeast Region) and the southeast states of Rio de Janeiro, São Paulo, and Minas Gerais; in addition, this was the only *Diachea* species recorded for Brazil between 1915 and 1996 (Putzke 1996).

More recently, *D. silvaepluvialis* and *D. bulbillosa* were recorded for the first time from Brazil and *D. leucopodia* for the first time from the state of Piauí (Mobin & Cavalcanti 1999, Bezerra et al. 2008).

Considering that knowledge on Brazilian myxomycetes is still fragmented and lacking baseline data on the distribution ranges of several species, and based on the characteristics of specimens from different states, the descriptions of three *Diachea* species are presented, along with comments on their distribution in the northeastern region of Brazil.

Materials and methods

Northeastern Brazil comprises nine states and occupies an area approximately 1,548,672 km² (IBGE 1985). With an extensive coast, the region also borders the states of Pará, Tocantins, Distrito Federal, Minas Gerais, and Espírito Santo. Although approximately 788,064 km² of the territory lies in the Caatinga biome, there are many different ecological areas in the Northeast; Atlantic forest fragments and associated ecosystems of the Mata Atlântica biome are found in the coastal region of the states of Bahia, Sergipe, Alagoas, Pernambuco, Paraíba, and Rio Grande do Norte; savanna and savanna-like vegetation islands also occur, especially in the states of Piauí and Ceará (Sampaio 1995, Araujo et al. 1998, Lemos & Rodal 2002).

In addition to bibliographical research, UFP, URM, UFBA, HUEFS, IPA, and JPB herbaria were surveyed for the *Diachea* species that occur in each state of Northeast Brazil. This was complemented by field trips carried out by the authors between 1995

and 2008 in the states of Alagoas, Paraíba, Pernambuco, Rio Grande do Norte, and Sergipe.

The taxonomic classification of Martin et al. (1983) was adopted for genera and suprageneric categories, while Martin & Alexopoulos (1969) and Farr (1976) were used for species identification. Selected specimens were used to illustrate the sporocarps and taxonomically significant microstructures.

Localities and their geographic coordinates were determined from field notes and herbaria records and later employed to create a map of species distribution in the northeastern region.

Abbreviations used in the text include states: BA= Bahia; MG= Minas Gerais; PE= Pernambuco; PI= Piauí; PR= Paraná; RN= Rio Grande do Norte; RS = Rio Grande do Sul; SC= Santa Catarina; SP= São Paulo and herbaria: HUEFS = Universidade Estadual de Feira de Santana, Bahia; IPA = Empresa Pernambucana de Pesquisa Agropecuária, Recife, Pernambuco; JPB= Universidade Federal da Paraíba, João Pessoa, Paraíba; UFBA= Universidade Federal da Bahia, Salvador, Bahia; UFP= Universidade Federal de Pernambuco, Departamento de Botânica, Recife, Pernambuco; URM = Universidade Federal de Pernambuco, Departamento de Micologia, Recife, Pernambuco.

Taxonomy

Diachea Fr., Syst. Orb. Veg.: 143. 1825.
= *Diachaeella* Höhn., Akad. Wiss. Wien. Sitzungsber., Math.-Naturwiss 118: 436. 1909.

Sporangiate, stipitate or sessile, sporotheca globose or cylindric; peridium simple, thin, iridescent, tending to be persistent; columella, and stipe when present, calcareous, rigid, thick, tapering upward; capillitium limeless, of delicate threads united into a net, the tips attached to the peridium; spores black or dark purple in mass.

Spore pigmentation as well as capillitial pigmentation and mode of branching closely resembles that of the *Stemonitaceae* (Kalyanasundaram & Mubarak Ali 1989); according to Martin et al. (1983), limeless species point toward a possible close relationship between *Diachea* and *Comatricha* Preuss.

Key to *Diachea* species of the northeast region of Brazil

- 1. Stalk white or brownish; spore 7.5–11(–12.2) µm diam.,
violet-brown or light brown 2
- 1a. Stalk dark orange or dark brown; spore 10–14 µm diam.,
dark purplish-brown *D. silvaepluvialis*
- 2. Sporotheca subglobose or obovate; capillitium a lax reticulum of
purplish threads.....*D. bulbillosa*
- 2a. Sporotheca cylindrical or elliptical; capillitium consisting of dark
reddish-brown, branched and anastomosed threads, pale at the tips
.....*D. leucopodia*

Species

Diachea bulbillosa (Berk. & Broome) Lister,

in Penzig, Myxomyc. Fl. Buitenzorg: 45. 1898.

FIGS. 1, 5

= *Didymium bulbillosum* Berk. & Broome, J. Linn. Soc., Bot. 14: 84. 1873.

Sporangia gregarious, stipitate, sporotheca subglobose or obovate, 335 – 430 µm diam., total height 1.2 mm; stalk 520 – 920 µm long, 335 – 350 µm at the base, 185 µm at the apex, calcareous, the lime aggregated into crystalline nodules with rhombohedron crystals; hypothallus inconspicuous; columella white, calcareous, capillitium lax, purplish threads united into a net, 1.5–3.0 µm diam.; spores dark in mass, violet-brown by transmitted light, globose to oval, with sparse and acute spines 1.5 µm long, 10(–12) µm in diam.

DISTRIBUTION IN BRAZIL: Northeast (PI).

SELECTED EXSICCATES: BRAZIL. PIAUÍ STATE: PIRIPIRI, Sete Cidades National Park, Piscina do Bacuri, Mitra Mobin 30, 24.II.1995, on dead leaf (petiole) of *Mauritia flexuosa* L.f., UFP 16506; Piscina do Bacuri, Mitra Mobin 106, 24.III.1995, on dead leaf (petiole) of *Mauritia flexuosa*, UFP 16582; Piscina do Bacuri, Mitra Mobin 196, 27.V.1995, on dead leaf (petiole) of *Mauritia flexuosa*, UFP 16671.

COMMENTS: Farr (1974) considers that if the structure of the lime is the sole character separating the genera *Didymium* (crystalline lime) and *Diderma* (granular lime), it would also be consistent to separate the granular-limed (temperate-zone material) and crystalline-limed (tropical or subtropical material) fruiting within *D. bulbillosa* at a species level. The Brazilian collections fit the species well, except for spores slightly larger than those found in temperate-zone specimens; they also have the typical rhombohedric crystals of tropical fruiting.

This is the second most common and widely distributed species of the genus (Farr 1974, Lado & Basanta 2008), but in Brazil it was found only at Piripiri County, Piauí State; all the specimens, collected in an area of secondary forest at the Sete Cidades National Park, were associated with *Arecaceae* (Mobin & Cavalcanti 1999).

Diachea leucopodia (Bull.) Rostaf., Sluzowce Monogr.: 190. 1874.

FIGS 2, 5

= *Trichia leucopodia* Bull., Hist. Champ. Fr. 1: 121. 1791.

Sporangia gregarious, stipitate, sporotheca cylindrical or elliptical, rarely globose, 410 µm diam. at the base and 260 µm diam. at the apex, total height 1 mm; hypothallus white, calcareous; stalk calcareous, white, 270 µm long, base 400 µm, apex 230 µm; peridium membranous, iridescent; columella cylindrical, calcareous, thick, white, reaching the top; capillitium dark reddish-brown, dense, with flexuous threads arising from all parts of the columella, 0.5–1.5 µm diam., paler at the tips; spores dark brown in mass, light brown by transmitted light, globose to oval, minutely roughened, 7.5–9 µm diam.

DISTRIBUTION IN BRAZIL: Northeast (BA, PE, PI), Southeast (MG, SP), and South (PR, SC, RS).

SELECTED EXSICCATES: **BRAZIL. PIAUÍ STATE:** PIRIPIRI, Sete Cidades National Park, Lagoa Seca, Mitra Mobin 24, 22.II.1995, on dead leaf (leaflet) of *Copernicia prunifera* (Mill.) H.E. Moore (carnauba palm), UFP 16500; Lagoa Seca, Mitra Mobin 28, 22.II.1995, on dead leaf (leaflet) of *Copernicia prunifera*, UFP 16502. **PERNAMBUCO STATE:** RECIFE, Dois Irmãos Forest, Nascimento, M. L., 11.VI.1976, UFP 2470; Pôrto, K. C. 5, 3.X.1980, on dead leaf, UFP5085; Correia, A. M. S., 28.XII.1981, UFP 5802; Espinheiro, Cavalcanti, L. H., UFP 2983; OLINDA, Chico Science Mangrove, Bezerra, A.C.C. 1, 17.XII.1998, bark of living *Laguncularia racemosa* (L.) C.F. Gaertn., UFP 28539; PESQUEIRA, Bezerra, M. F. A. 51, 29.I.2002, UFP 31705; IGARASSU, Cavalcanti L. H. 1999, dead leaves, UFP 2858; MIRANDIBA, Ferreira, I.N. et al 31, 28.VI.2008, on xique-xique, UFP 54364; RIO FORMOSO, Nossa Senhora do Ó Mangrove, Damasceno, G.S. 21, 26.IV.2007, on aerial litter of *Conocarpus erectus* L. UFP 46328. **RIO GRANDE DO NORTE STATE:** BAIA FORMOSA, Mata Estrela, Bezerra, A. C. C. 852, 08.V.2007, on dead wood, UFP 55933; Mata Estrela, Bezerra, A. C. C. 853, 08.V.2007, on dead leaf, UFP 55934.

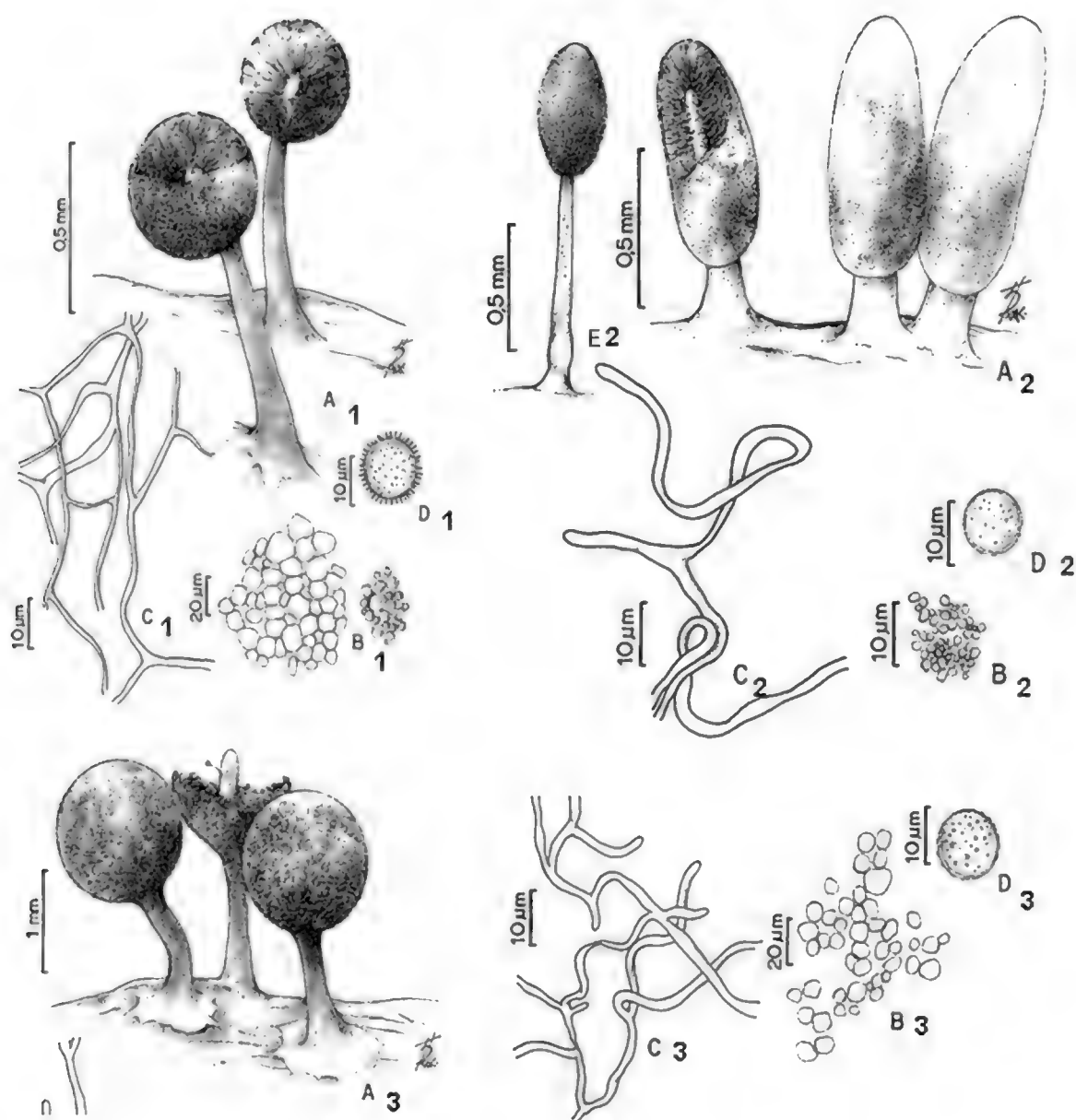
COMMENTS: To date, all studies show that this is the most common and abundant *Diachea* species in the Neotropics. However, this widely distributed cosmopolitan species has only been recorded once for Bahia (Torrend 1915; municipality not noted), twice for Piauí (Mobin & Cavalcanti 2000), and nine times for Pernambuco, without records for the other northeastern states. In the Northeast region it is seldom found in large numbers of specimens, but frequently reaches large fructifications, especially in Atlantic forest remnants. One specimen (UFP 28539) was collected in the municipality of Olinda-PE at the Chico Science mangrove, an unusual environment for myxomycetes; the sporangia, which developed on the bark of *Laguncularia racemosa* in moist chamber cultures, had very long stalks associated with a long cylindrical sporotheca (FIG. 2a); thus, this collection is referred to as *D. leucopodia* with some caution. Two specimens of *D. leucopodia* were collected by Mobin & Cavalcanti (2000) at the Sete Cidades National Park, associated with *Copernicia prunifera* (*Arecaceae*) in a savanna area. This is the first record of this species for Rio Grande do Norte state.

Diachea silvaepluvialis M. L. Farr, Contr. U. S. Natl. Herb.

37(6): 409. 1969.

FIGS. 3–5)

Sporangia gregarious, stipitate, sporotheca globose to subglobose, dark-brown, 400 µm diam., 800–1000 µm total height; stipe calcareous, dark orange or dark brown, tapering toward the apex, striate, lime crystals 5–15 µm diam.; columella more or less cylindrical, tapering upward, reaching nearly half the height of the sporotheca; peridium iridescent, usually persisting at the base, pale brown; capillitium lax, arising along the entire columella, forming a lax reticulum, with dark brown filaments 1–2 µm diam., and slightly paler free ends; hypothallus



FIGURES 1–3. 1. *Diachea bulbilosa*: A- sporocarps and columella; B- rhombohedron crystals of the stalk; C- capillitium; D spores. 2. *D. leucopodia*: A- sporocarps and columella; B- rhombohedron crystals of the stalk; C- capillitium; D- spore; E- sporocarp of the specimen collected in mangrove forest, with a very long stalk. 3. *D. silvaepluvialis*: A- sporocarps and columella; B- rhombohedron crystals of the stalk; C- capillitium; D- spore.

membranous, discoid, brownish, sometimes obsolete; spores dark brown in mass, dark purplish brown by transmitted light, sparsely to closely spinulose, sometimes densely warted, 10–14 μ m diam.

DISTRIBUTION IN BRAZIL: Northeast (SE).

SELECTED EXSICCATES: BRAZIL. PARAÍBA STATE: AREIA, Mata do Pau Ferro Ecological Reserve, Boa Vista trail, Costa, A. A. A. 36A, 03.VI. 2005, on dead wood and dead leaf, UFP 41869. **SERGIPE STATE:** AREIA BRANCA, Serra de Itabaiana National Park, Bezerra, M. F. A. 134, 13.IV.2002, dead leaf, UFP 34352. **PERNAMBUCO STATE:** SÃO VICENTE FERRER, Mata do Estado, Ferreira, I.N. et al 89, on dead leaf, UFP 48487.

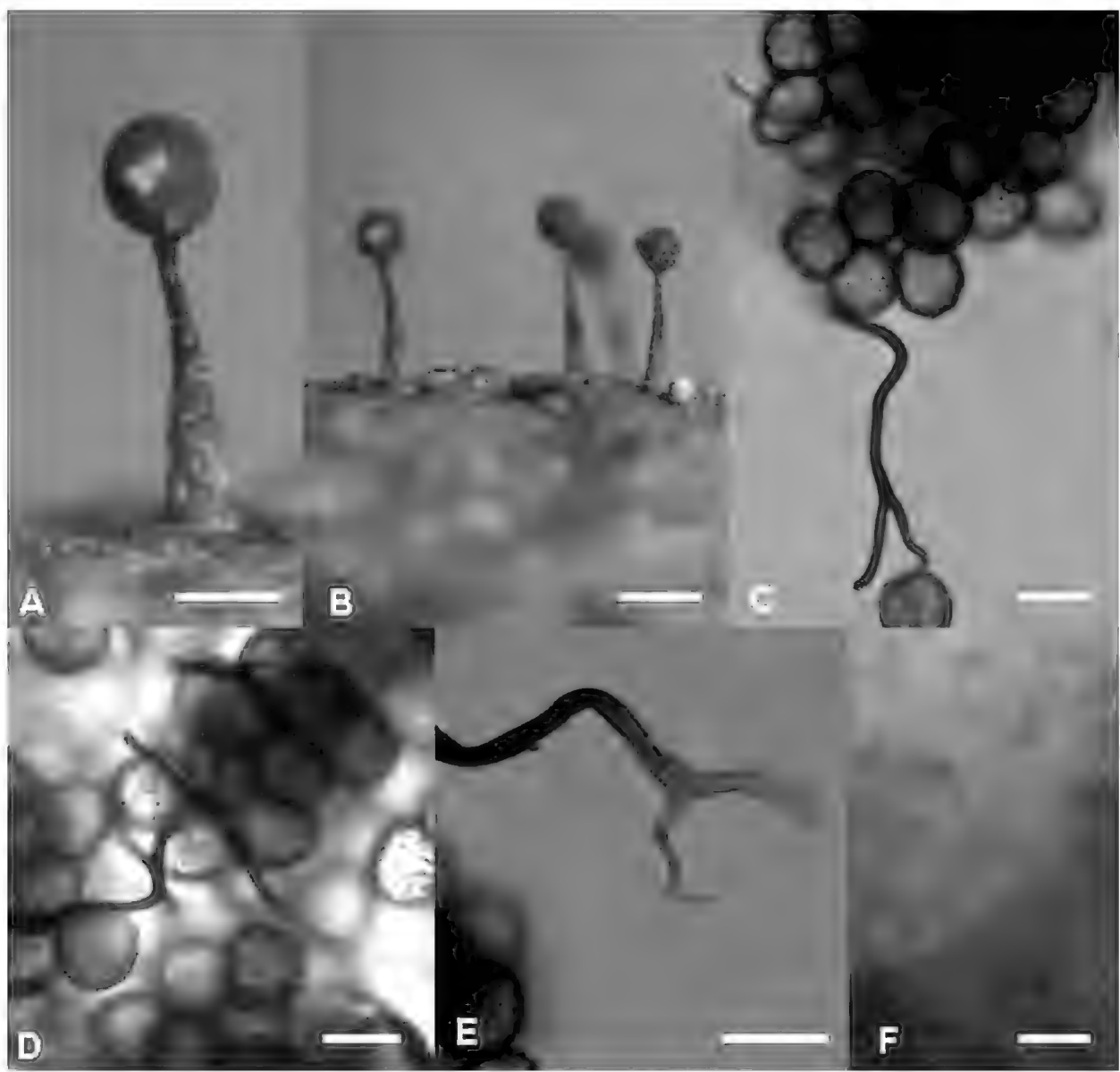


FIGURE 4. *Diachea silvaepluvialis* (UFP 41869): A and B - sporocarps; C and D - capillitium and spores; E - capillitium; F- rhombohedron crystals of the stalk.

Scale bars: A = 250 μ m. B = 500 μ m. C-F = 10 μ m.

COMMENTS: This species has been collected in three reserves of Atlantic forest, in the states of Paraíba, Pernambuco, and Sergipe, at altitudes above 400 m. However, further fieldwork may prove that it is widespread in the northeastern part of the country. This is the first record of *D. silvaepluvialis* for Paraíba and Pernambuco states.

Conclusions

The available data show that 25% of the known *Diachea* species are represented in Northeast Brazil, occurring in savanna, ombrophilous forest, stationary semideciduous lowland forest, riverine forest and in the submontane forests regionally known as “brejos de altitude”.

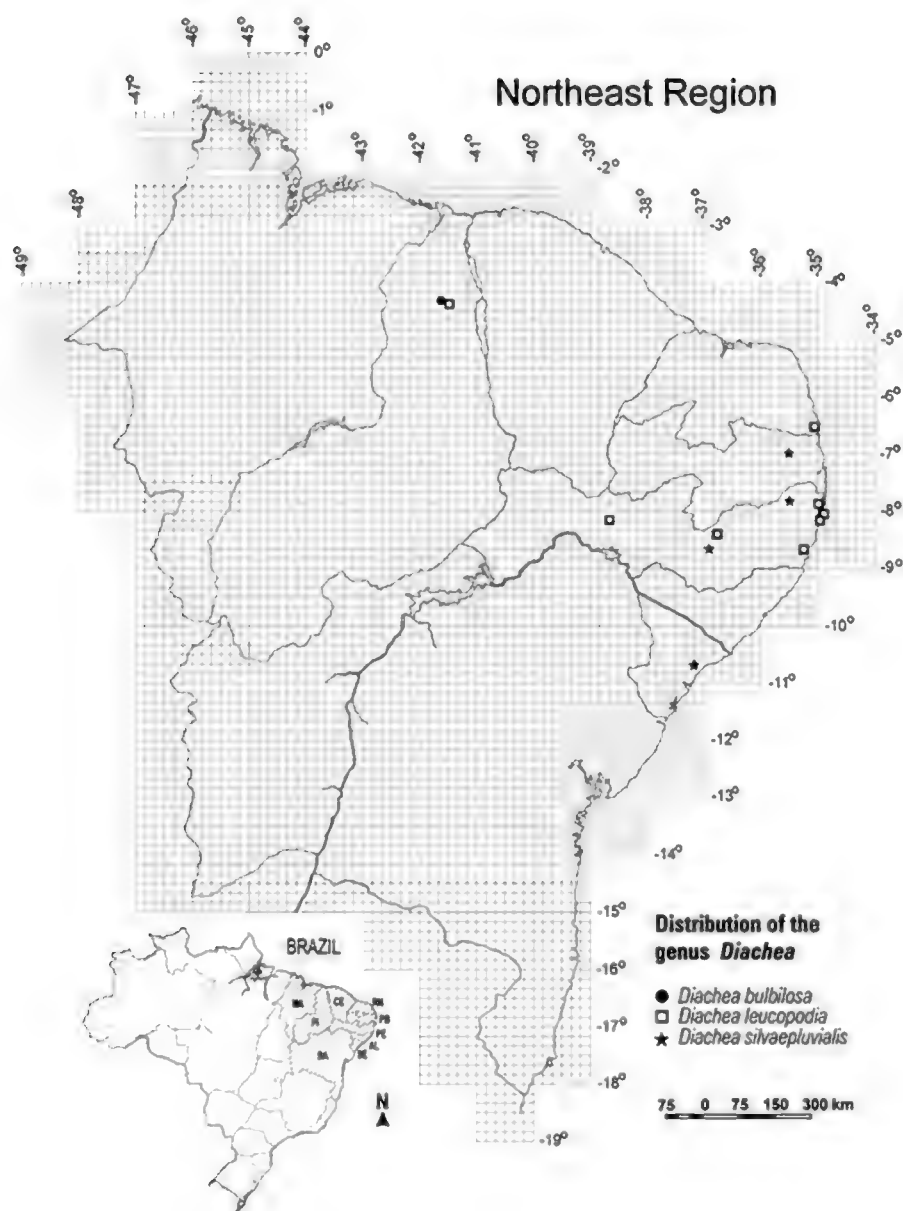


FIGURE 5. Distribution of *Diachea bulbilosa*, *D. leucopodia*, and *D. silvaepluvialis* in Northeast Brazil.

Sporocarps of the three species may be found during different seasons and in different environments, including mangroves, as corticolous, foliicolous, or lignicolous, and the largest populations were found in the Atlantic forest. Until now, *D. silvaepluvialis* has been recorded exclusively in Atlantic Forest remnants, covered with open ombrophilous or riverine forest, 400–600 m above sea level.

Acknowledgments

The authors are grateful to the curators that allowed access to material deposited at the IPA, UFP, URM, and JPB Herbaria; to the Sete Cidades National Park and Serra de Itabaiana Ecological Reserve staff for support during field work; to Frank Valdomiro da Silva for the illustrations; and to Dr. Aristóteles Góes Neto for the complementary

information on the species that occur in the state of Bahia. Thanks are also given to Dr. Gabriel Moreno and Dr. Luis Fernando P. Gusmão for their revision of the manuscript.

Literature cited

- Araujo FS, Sampaio EVSB, Figueiredo MA, Rodal MJN, Fernandes AG. 1998. Composição florística da vegetação de carrasco. *Revista Brasileira de Botânica* 21(2): 105–116.
- Bezerra MFA, Bezerra ACC, Nunes AT, Lado C, Cavalcanti LH. 2008. Mixobiota do Parque Nacional Serra de Itabaiana, SE, Brasil: *Physarales*. *Acta Botanica Brasilica* 22(4): 1044–1056.
- Farr ML. 1974. Some new *Myxomycetes* records for the Neotropics and some taxonomic problems in the *Myxomycetes*. *Proceedings of the Iowa Academy of Science* 81: 37–40.
- Farr ML. 1976. *Myxomycetes*. pp. 1–305, in CT Rogerson (org.), *Flora Neotropica Monograph* 16. New York, New York Botanical Garden.
- Fiore-Donno AM, Berney C, Pawlowsky J, Baldauf SL. 2005. Higher order phylogeny of plasmodial slime-molds (*Myxogastria*) based on elongation factor 1-A and small subunit rRNA gene sequence. *Journal of Eukaryotic Microbiology* 52(3): 201–210.
- Fries EM. 1825. *Systema orbis vegetabilis*. Primas lineas novae constructionis. Pars I. Plantae homonemeae. Lund.
- Fundação Instituto Brasileiro de Geografia e Estatística – IBGE. 1985. *Atlas Nacional do Brasil (Região Nordeste)*, Rio de Janeiro.
- Gaither TW, Keller H. 2004. Taxonomic comparison of *Diachea subsessilis* and *D. deviata* (*Myxomycetes*, *Didymiaceae*) using scanning electron microscopy. *Systematics and Geography of Plants* 74(1): 217–230.
- Hagelstein R. 1944. *The Mycetozoa of North America*. Mineola, New York.
- Hernández-Crespo JC, Lado C. 2005. An on-line nomenclatural information system of Eumycetozoa. Retrieved November 26, 2006, from <http://www.nomen.eumycetozoa.com>.
- Kalyanasundaram I, Mubarak Ali N. 1989. Taxonomic note on the myxomycete genus *Diachea*. *Mycological Research* 93(2): 235–237.
- Keller H, Skrabal M, Eliasson UH, Gaither TW. 2004. Tree canopy biodiversity in the Great Smoky Mountains National Park: ecological and developmental observations of a new *myxomycete* species of *Diachea*. *Mycologia* 96(3): 537–547.
- Lado C. 2001. *Nomenmyx – A nomenclatural Taxabase of Myxomycetes*. Cuadernos de Trabajo de Flora Micológica Ibérica 16. Madrid, Real Jardín Botánico.
- Lado C, Basanta DW. 2008. A review of Neotropical *Myxomycetes* (1828–2008). *Anales del Jardín Botánico de Madrid* 65(2): 211–254.
- Lemos JR, Rodal MJN. 2002. Fitossociologia do componente lenhoso de um trecho da vegetação de caatinga no Parque Nacional Serra da Capivara, Piauí, Brasil. *Acta Botanica Brasilica* 16(1): 23–42.
- Lister A. 1925. *A Monograph of the Mycetozoa*. London, British Museum Natural History.
- Martin GW, Alexopoulos CJ. 1969. *The Myxomycetes*. Iowa City, University of Iowa Press.
- Martin GW, Alexopoulos CJ, Farr ML. 1983. *The genera of Myxomycetes*. Iowa City, University of Iowa Press.
- Mobin M, Cavalcanti LH. 1999. *Physarales (Myxomycetes)* do Parque Nacional de Sete Cidades, Piauí, Brasil. *Hoehnea* 26(1): 1–14.
- Mobin M, Cavalcanti LH. 2000. *Myxomycetes* em Carnaúba (*Copernicea prunifera*, *Arecaceae*). *Acta Botanica Brasilica* 14(1): 71–75.
- Putzke J. 1996. *Myxomycetes* no Brasil. *Cadernos de Pesquisa, Série Botânica* 8: 1–133.

- Sampaio EVSB. 1995. Overview of the Brazilian Caatinga. pp. 35–63, in SH Bullock, HA Mooney, E Medina (eds), Seasonal dry tropical forests. Cambridge University Press, London.
- Torrend C. 1915. *Myxomycetes* du Brésil, connus jusqu'ici. Broteria 13: 72–88.
- Torrend C. 1916. Os *Myxomycetes* dos arredores da Bahia. pp. 484–492, in L Anon (ed.), Anais do 5º Congresso Brasileiro de Geografia. Salvador, Sociedade Brasileira de Geografia.

***Puccinia subepidermalis* sp. nov. and new records of rust fungi from Fairy Meadows, Northern Pakistan**

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Abstract — Five rust species from Fairy Meadows in the Northern Areas of Pakistan are herein described from a recent urediniological survey. *Puccinia subepidermalis* infecting *Carex curta* is proposed as a new rust species from Pakistan and is distinguished from similar *Puccinia* sp. found on the same host. *P. praegracilis* infecting *Agrostis stolonifera* is reported as a new record from Pakistan, and *P. nepalensis* infecting *Rumex nepalensis* and *P. hieracii* var. *hieracii* infecting *Picris nuristanica* are new reports from Fairy Meadows, Northern Areas of Pakistan. A re-description of *Puccinia violae* infecting *Viola caespitosa* including SEM photographs is presented.

Key words — Kaghan valley, Nanga Parbat, *Puccinia caricis*

Introduction

The Northern Areas of Pakistan, lying under the great mountain ranges of Himalaya–Karakorum–Hindu Kush–Hindu Raj and Pamir surrounded by high peaks of 6500–8600 meters, is the most spectacular and fascinating region of Pakistan. In the heart of northern Pakistan, Fairy Meadows is located at the base of Nanga Parbat, which, at 8126 m, is the 9th highest mountain in the world and second in Pakistan after K2. The Fairy Meadows are lush green alpine pastures situated in the middle of a pine forest at an altitude of 3306 m. The pine forests skirting Fairy Meadows are one of the virgin forests in the North of Pakistan and home to a number of species of wild flowers, birds, and wildlife (Singh et al. 2004: 190–191). The altitudinal range of the Fairy Meadows vegetation belt is defined as montane belt. Although the montane belt on Fairy Meadows/Nanga Parbat is by far the richest in species number and potential

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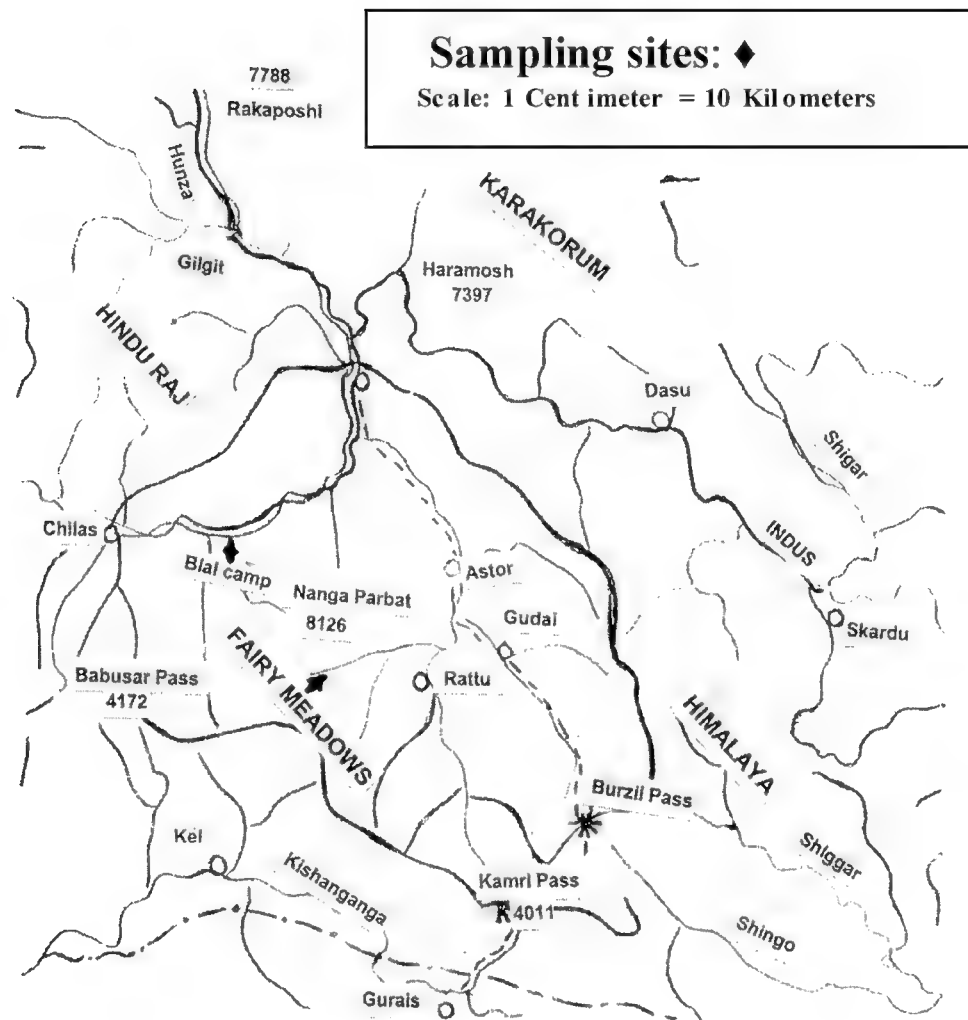


FIG. 1. Map of Fairy Meadows, Northern Areas of Pakistan, showing sampling sites

differentiation of vegetation types, it is floristically depauperate as compared to the outer Himalayan slopes (Troll 1939).

Locally, *Leontopodium campestre* Hand.-Mazz. and other herbs resistant to drought and grazing are plentiful. The ground layer of dry pure *Pinus wallichiana* A.B. Jacks. forests of the lower altitudes is widely dominated by a thin compost of dead pine needles. The companion flora of herbs and shrubs is relatively rich in species including *Androsace thomsonii* (Watt) Y. Nasir, *Artemisia japonica* Thunb., *Astragalus candolleanus* Boiss., *Bromus confinis* Nees ex Steud., *Geranium himalayense* Klotzsch, *Impatiens brachycentra* Kar. & Kir., *Rubus irritans* Focke, *Silene vulgaris* (Moench) Garcke and *Ribes nigrum* L. Moist areas by the stream-sides are characterized by *Salix* shrubberies (*S. wallichiana* Andersson, *S. sericocarpa* Andersson), occasionally with *Rosa macrophylla* Lindl., *Cotoneaster affinis* Hohen. ex Hook. f. and the herbaceous species *Rubus saxatilis* L. (Nüsser & Dickoré 2000: 13–26).

During a recent survey of the rust fungi in the Northern Areas of Pakistan, specifically Fairy Meadows, five species of rusts were encountered. Previously,

66 species of rust fungi have been reported from this area (Iqbal et al. 2009). In this paper, *Puccinia subepidermalis* on *Carex curta* is reported as new to science. In addition, *P. praegracilis* represents a new record for Pakistan while *P. nepalensis* and *P. hieracii* var. *hieracii* are reported for the first time from this region. *Puccinia violae*, previously reported from Pakistan, is re-described to illustrate important morphological features with the help of scanning electron microscopy.

Materials and methods

Specimens were collected from the Northern Areas (Fairy Meadows) of Pakistan (FIG. 1). Freehand sections of infected tissues and spores were mounted in lactophenol and gently heated to boiling. The preparations were observed under a NIKON YS 100 microscope and photographed with a digipro-Labomed and JSM5910 scanning electron microscope. Spores and paraphyses were drawn using a camera lucida (Ernst Leitz Wetzlar, Germany). Spores were measured with an ocular micrometer. At least 25 spores were measured for each spore state. The specimens were deposited in the Herbarium of the Botany Department, University of the Punjab, Lahore (LAH).

Enumeration of taxa

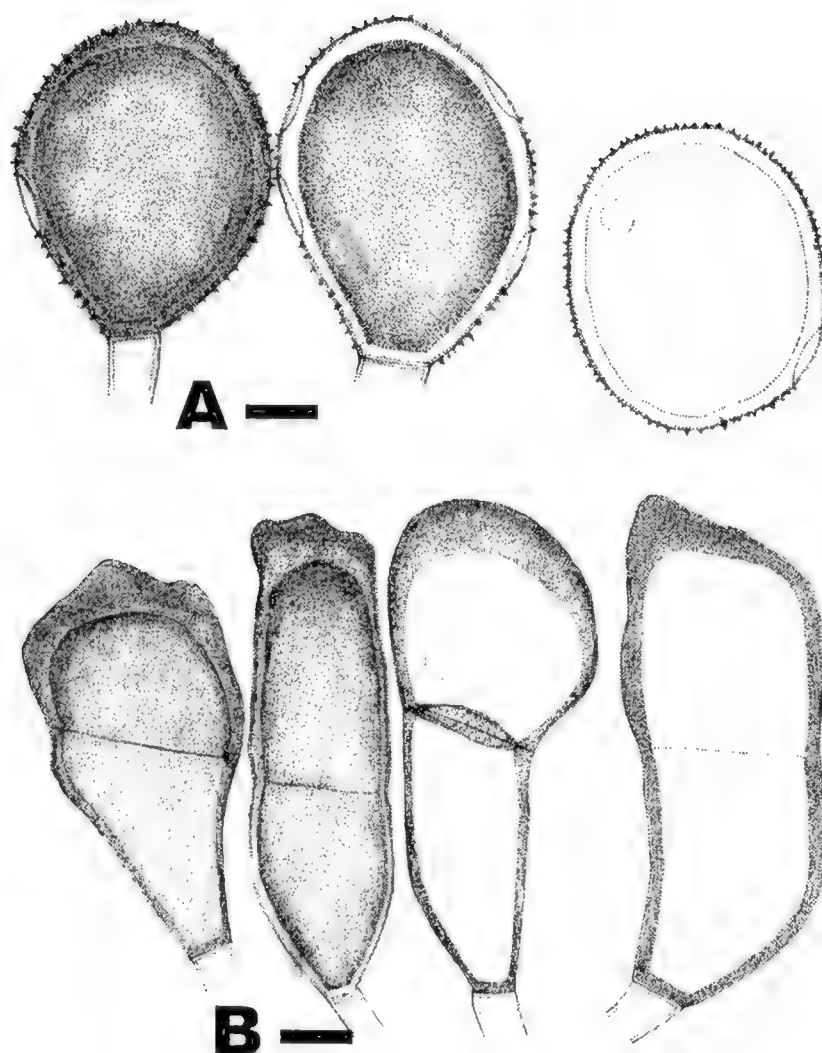
Puccinia subepidermalis Afshan, Khalid & S.H. Iqbal, sp. nov. FIGS. A–B, TABLE 1
MYCOBANK MB 515049

Spermogonia et aecia ignota. Uredinia amphigena, subepidermalia, dilute brunnea. Urediniosporae globosae vel subglobosae, obovoideae; 23–27(–31) × 20–24 µm; membrana 1.5–2 µm crassa, pallidae-brunneae, echinulatae; poris germinationis 2–5, aequatorialibus, pedicellis hyalinis, usque ad 15 µm longis. Paraphysibus clavatis vel capitatis, hyalinae vel dilute flavidae, apice 18–22 µm crasso, membrana 2 µm crasso, usque ad 75–90 µm longo. Telia amphigena, subepidermalia, brunnea. Teliosporae 1–2 cellulares, clavatae, ellipsoideae vel oblongae; (34–)38–51(–58) × 15–20(–24) µm, membrana 2–3 µm crassa, apicaliter brunneae vel castaneo-brunneae, basaliter pallidae, pariete levi; apice truncato vel conico, 4–6 µm crasso; pedicello brunneo, usque ad 4–7 × 8 µm.

HOLOTYPE: On *Carex curta* Gooden., with II and III stages, Pakistan, Northern Areas, Fairy Meadows, 3036 m a.s.l., 12th August, 2007. NSA #G35. (LAH Herbarium No. NSA 1094).

ETYMOLOGY: Named due to the presence of subepidermal sori.

SPERMOGONIA and **AECIA** not found. **UREDINIA** amphigenous, subepidermal, pale brown, 0.6–0.8 × 1.9–2.0 mm. **UREDINIOSPORES** globose to subglobose or obovoid, 23–27(–31) × 20–24 µm (mean 19.4 × 18.8 µm); wall 1.5–2 µm thick, orange to golden brown, echinulate; germ pores 2–5, equatorial; pedicel hyaline, 5–6 µm wide and up to 15 µm long. **PARAPHYSES** clavate to capitate, hyaline to pale yellow, head 18–22 µm wide, wall up to 2 µm thick, 75–90 µm long. **TELIA** amphigenous, subepidermal, dark brown, 0.4–0.7 × 0.6–0.8 mm. **TELIOspores** 1–2 celled, ellipsoid to oblong or clavate; wall 2–3 µm thick,



FIGS. A–B: Lucida drawings of *Puccinia subepidermalis* (type)
(A). Urediniospores (B). Teliospores. Scale bars = 10 μm .

golden brown to chestnut brown but paler basally, smooth; (34–)38–51(–58) \times 15–20(–24) μm (mean $44.3 \times 15.4 \mu\text{m}$); apex truncate or conical to obliquely conical, 4–6 μm thick; germ pore 1 per cell, obscure; pedicel short, brown, 4–7 μm wide and up to 8 μm long.

COMMENTS: Rust fungi on *Carex* spp. previously reported from Pakistan include *Puccinia caricina* DC. 1815 and *P. caricis-filicinae* Barclay 1889 on *Carex filicina* Nees, and *P. dioicae* Magnus 1877 and *P. pakistani* S. Ahmad 1961 on *Carex nubigena* D. Don (Ahmad et al. 1997). About seventy species of *Puccinia* have been reported on species of *Carex* throughout the world (Arthur & Cummins 1962, Wilson & Henderson 1966, Hiratsuka et al. 1992, Hennen et al. 2005).

Puccinia subepidermalis is characterized by the presence of clavate to capitate uredinial paraphyses with short pedicels of teliospores. The presence of 1–2-celled teliospores with truncate or conical to obliquely conical apices also distinguish this species from other species reported on *Cyperaceae*. (A comparison of *P. subepidermalis* with similar species is presented in TABLE 1).

Puccinia subepidermalis resembles *P. caricis* Rebent. 1804 in the size of urediniospores. However, *P. subepidermalis* has clavate to capitate uredinial paraphyses and shorter pedicels (8 µm vs. 45 µm) of teliospores than those of *P. caricis*. Moreover, presence of 1–2-celled teliospores with truncate or conical to obliquely conical apices differentiates *P. subepidermalis* from *P. caricis*, which has two-celled teliospores with rounded apices.

The new species has a few characters similar to *P. caricis-japonicae* Dietel 1906 including size and spore wall ornamentation. But these species are differentiated by the presence of clavate to capitate uredinial paraphyses and 1–2-celled teliospores in *P. subepidermalis*.

TABLE 1. Comparison of *Puccinia subepidermalis* with similar *Puccinia* spp.

<i>P. SUBEPIDERMALIS</i>	<i>P. CARICIS</i>	<i>P. CARICIS-JAPONICAE</i>	<i>P. CARICIS-SHIMIDZENSIS</i>
UREDINIA			
Amphigenous, subepidermal	Amphigenous, mostly hypophyllous, erumpent	Hypophyllous, subepidermal	Hypophyllous, subepidermal
UREDINIOSPORES			
(Sub)globose or obovoid	Subglobose or obovoid	Ellipsoid or obovate	Globose or ovate
Orange to golden brown	Light brown to brown	Yellowish brown	Yellowish brown
Echinulate	Echinulate	Minutely echinulate	Verrucose to echinulate
GERM PORES (equatorial)			
2–5	3 (rarely 2 or 4)	3–4	2–3
SIZE (µm)			
23–27(–31) × 20–24	23–32 × 20–23	20–29 × 18–24	23–31 × 21–27
PARAPHYSES			
Abundant (clavate to capitate)	Absent	Absent	Absent
TELIOSPORES			
Amphigenous, subepidermal, loculate	Hypophyllous, erumpent	Hypophyllous, naked	Hypophyllous, naked
1–2-celled	2-celled	2-celled	2-celled
Ellipsoid to oblong or clavate	Clavate	Clavate	Clavate or ellipsoid
Golden/chestnut brown, paler basally	Light brown	Yellowish brown to yellowish	Brown
(34–)38–51(–58) × 15–20(–24) µm	42–64 × 14–23 µm	39–56 × 11–18 µm	39–53 × 18–27 µm
APEX (µm thick)			
4–6	8–17	Unknown	9–10
PEDICEL			
Brown, ≤ 8 µm long (4–7 µm diam)	Pale brown, 24–45 µm long	Hyaline or brown, 25 µm long	Hyaline or yellowish, 21 µm long

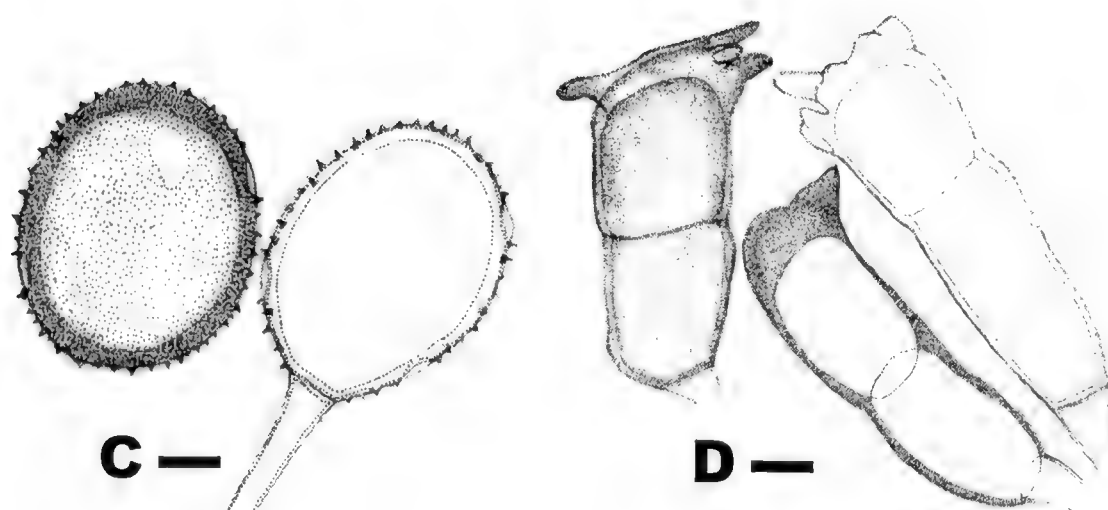
Puccinia subepidermalis is differentiated from *P. caricis-shimidzensis* Homma 1938 by spore size. *P. subepidermalis* has narrower urediniospores (20–24 μm vs. 21–27 μm) and teliospores (15–20(–24) μm vs. 18–27 μm) than *P. caricis-shimidzensis*. *P. subepidermalis* also has 1–2-celled teliospores with shorter (8 μm vs. 21 μm) pedicels and clavate to capitate uredinial paraphyses compared with the two-celled teliospores with longer pedicels of *P. caricis-shimidzensis*. The later also lacks uredinial paraphyses.

The new species also has few characters similar to *P. mandshurica* Miura 1928, but both species can be differentiated by the size of spores. *Puccinia subepidermalis* has larger urediniospores (23–27(–31) \times 20–24 μm vs. 28–36 \times 18–25 μm) and teliospores ((34–)38–51(–58) \times 15–20(–24) μm vs. 36–50 \times 10–15 μm) than in *P. mandshurica*. Moreover, the presence of echinulated urediniospores and 1–2-celled teliospores differentiates *P. subepidermalis* from *P. mandshurica* which has verrucose urediniospore wall ornamentation and two-celled teliospores.

Puccinia praegracilis Arthur, Hedwigia 37: 273 (1898)

FIGS. C–D

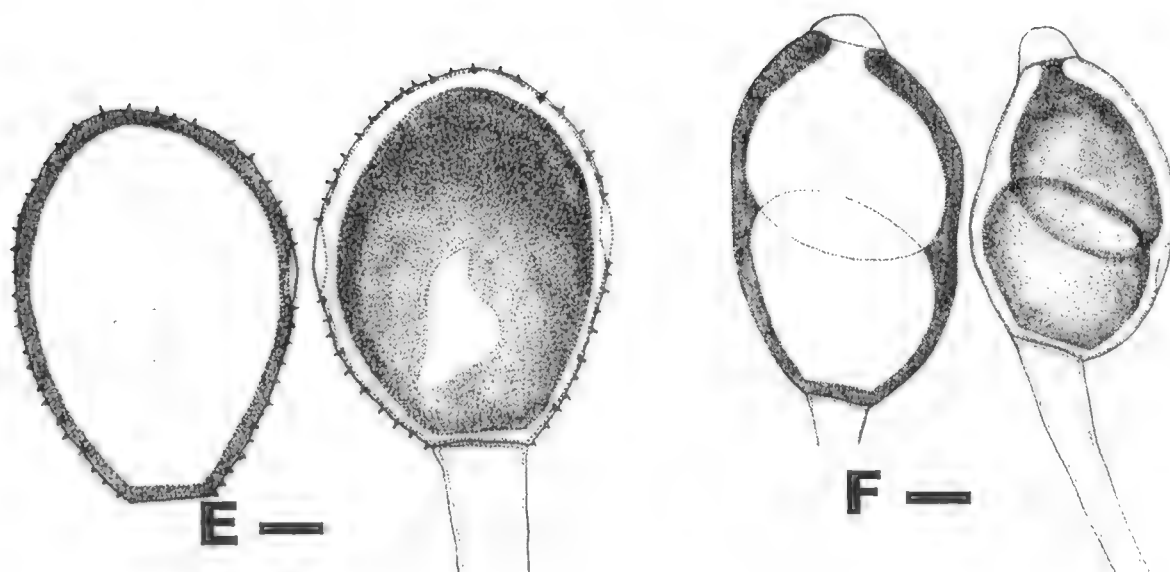
SPERMOGONIA and AECIA not found. UREDINIA amphigenous, mostly on adaxial surface, yellow to yellowish brown. UREDINIOSPORES globose to ellipsoid or broadly obovoid, (16–)20–22 \times (13–)16–21 μm ; wall 1–1.5 μm thick, hyaline to pale yellow, echinulate; germ pores 5–7, scattered, obscure; pedicel colorless, minute. TELIA subepidermal, mostly amphigenous or on abaxial surface, dark brown to blackish brown, with brownish stromatic paraphyses tending to divide sorus into locules, 0.2–0.5 \times 0.3–0.8 mm. TELIOSPORES elongated to obovoid or cylindrical to clavate, 37–44(–47) \times 13–16(–21) μm (mean 41.6 \times 16.9 μm); wall 0.5–1 μm thick at sides, 3–7 μm apically excluding digitations, golden brown to chestnut brown, smooth; with a few digitations, 3–6 μm long; pedicels short, mostly less than 15 μm long, 10–12 \times 5–8 μm .



FIGS. C–D: Lucida drawings of *Puccinia praegracilis* (C). Echinulate urediniospores (D). Teliospores. Scale bars = 10 μm .

MATERIAL EXAMINED: On *Agrostis stolonifera* L., with II & III stages, Pakistan, Northern Areas, Fairy Meadows, at 3,036 m a. s. l., 12th August, 2007, NSA #G 50. (LAH Herbarium No. NSA 1078).

COMMENTS: *Puccinia praeegracilis* has previously been reported on *Agrostis thurberiana* Hitchc. from Western Canada (Cummins 1971). It is a new record for Pakistan.



FIGS. E–F: *Puccinia nepalensis*

(E). Echinulate urediniospores showing equatorial germ pores (F) Teliospores.

Scale bars = 10 μ m.

Puccinia nepalensis Barclay & Dietel, Hedwigia 29: 265 (1890)

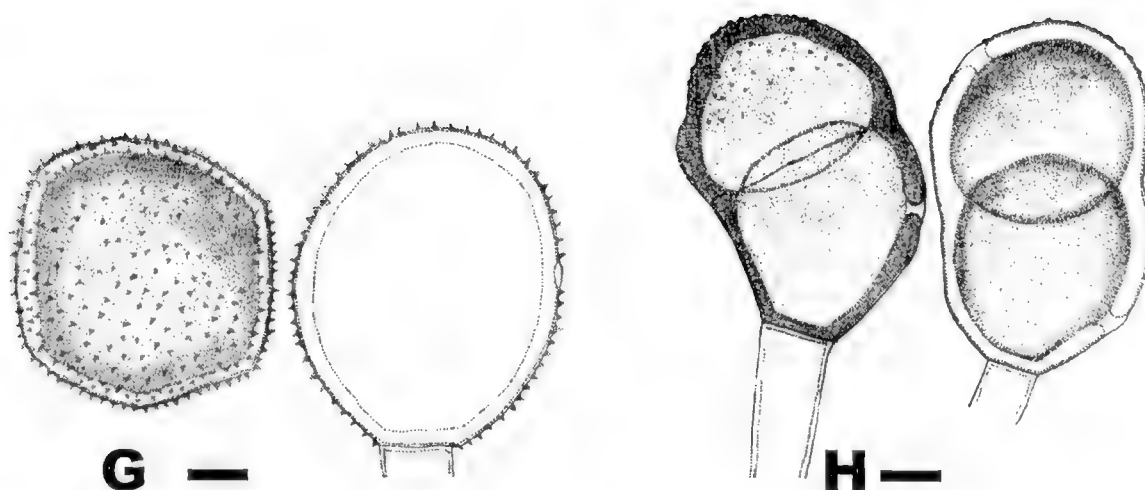
FIGS. E–F

SPERMOGONIA and AECIA not seen. UREDINIA intermixed with telia, amphigenous, scattered or in groups, sometimes circinate, cinnamon brown, pulverulent, 0.07–0.1 \times 0.07–0.2 mm. UREDINIOSPORES globose or ovoid; wall 1–1.5 μ m thick, echinulate, yellowish brown to cinnamon brown; 23–30 \times 18–22 μ m; germ pores 2, equatorial. TELIA similar, dark brown to blackish brown. TELIOSPORES ellipsoid, rounded at both ends, slightly constricted at septum, 29–38(–42) \times 21–24 μ m, with a hyaline papilla at apex next to septum, apex 4–5 μ m thick; wall 1.5–2 μ m thick, smooth, cinnamon brown; pedicel hyaline, 30 \times 6–7 μ m.

MATERIAL EXAMINED: On *Rumex nepalensis* Spreng., with II + III stages, Pakistan, Northern Areas, Fairy Meadows, at 3,036 m a.s.l., 12th August, 2007. NSA # G 17. (LAH Herbarium No. NSA 1072).

COMMENTS: *Puccinia nepalensis* has previously been reported on *Rumex nepalensis* from Changla Gali, Hazara, Kaghan Valley, Murree, Muzaffarabad (Azad Jammu & Kashmir), Naran, Saiful Maluk and Swat (Ahmad et al. 1997).

Sultan (2005) reported *P. nepalensis* on *Rumex nepalensis* from Hunza Valley. This is a new record from Fairy Meadows.



FIGS. G–H: *Puccinia hieracii* var. *hieracii*

(G). Urediniospores showing germ pore (H). Teliospores showing one germ pore in each cell.
Scale bar for G = 10 μm & H = 13 μm .

***Puccinia hieracii* (Röhl.) H. Mart., Prodr. Fl. Mosq. 2: 226 (1817)**
var. *hieracii*

FIGS. G–H

SPERMOGONIA and AECIA not found. UREDINIA amphigenous, mostly hypophyllous, surrounded by ruptured epidermis, brown, scattered over surface, early naked, 0.2–0.4 \times 0.1–0.5 mm. UREDINIOSPORES globose to ellipsoid or sometimes angularly ellipsoid, 23–37 \times 22–32 μm (mean 30.4 \times 26.6 μm); wall 2–3 μm thick, brown to chestnut brown, densely echinulate; germ pores 2–4, obscure, scattered; pedicel hyaline, minute, fragile, 12–15 \times 6–8 μm . TELIA mostly amphigenous, 0.2–0.6 \times 0.2–0.4 mm, black. TELIOSPORES ellipsoid to clavate, rounded at both ends, not or slightly constricted at septum, (29–)30–45(–48) \times 21–30(–34) μm (mean 38.0 \times 27.1 μm); wall 2–3 μm thick, verruculose, becoming smooth at lower side, chestnut brown; not thickened at apex; germ pore of upper cell sub-apical, of lower cell at equator or near septum; pedicel short, hyaline, 10–15 \times 8–9 μm .

MATERIAL EXAMINED: On *Picris nuristanica* Bornm. (*P. hieracioides* L.), with II + III stages, Pakistan, Northern Areas, Fairy Meadows, at 3,036 m a. s. l., 12th August, 2007. NSA # G 12. (LAH Herbarium No. NSA 1059).

COMMENTS: *Puccinia hieracii* var. *hieracii* has been reported on *Taraxacum officinale* Weber from Batakundi, Kaghan, Kalam, and Swat (Ahmad 1956a,b). It is a new record for Fairy Meadows, Northern Areas of Pakistan and *Picris nuristanica* is also a new host for this rust fungus from Pakistan.

***Puccinia violae* (Schumach.) DC., Fl. franç., Edn 3, 6: 62 (1815)**

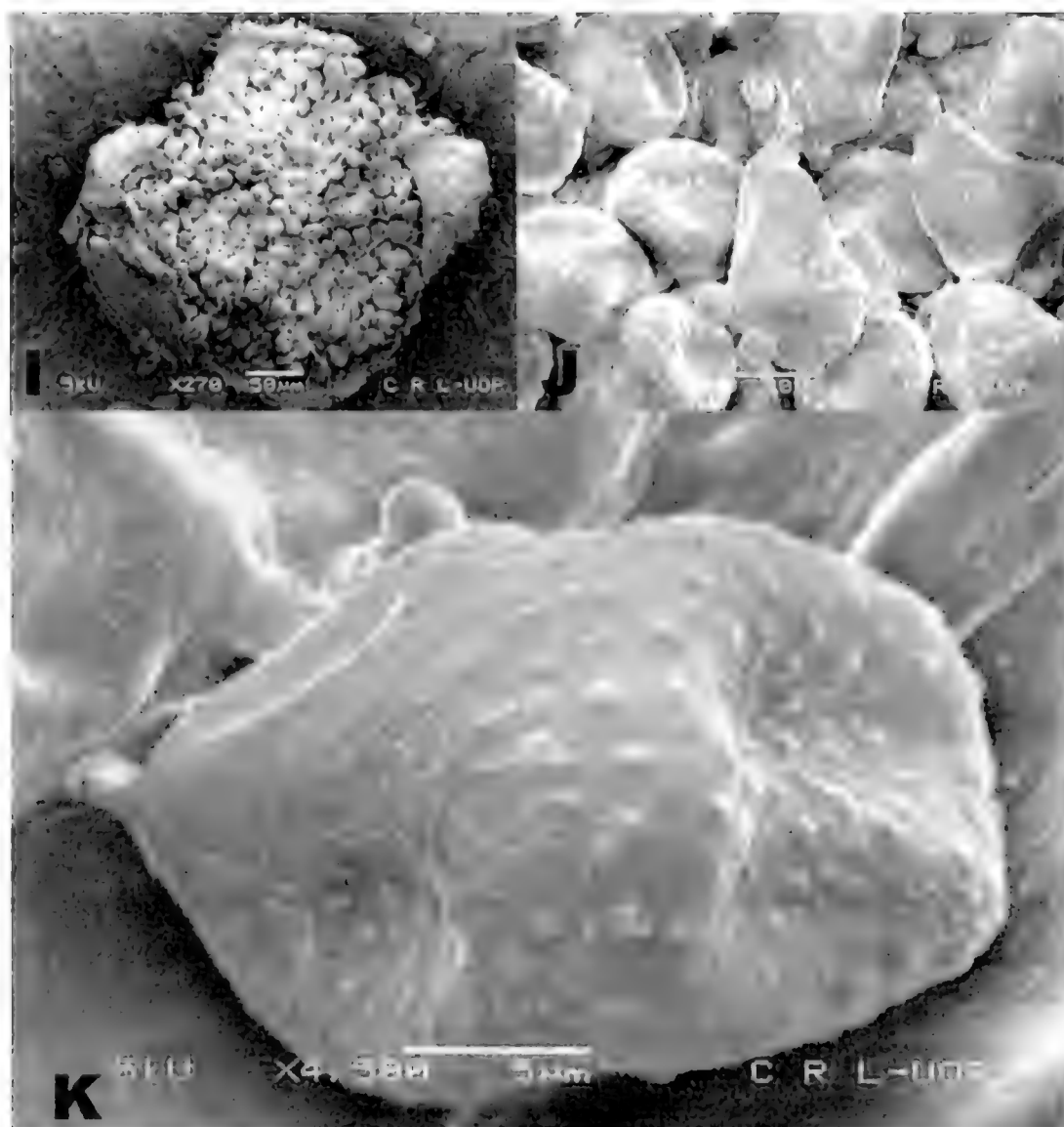
FIGS. I–K

SPERMOGONIA and AECIA unknown. UREDINIA hypophyllous, scattered or circinate, soon naked, pulverulent, brown, 0.1–0.2 \times 0.2–0.4 mm. UREDINIOSPORES globose to obovoid or ellipsoid, 20–27 \times 17–22 μm (mean 23.6 \times 20.2 μm); wall 1.5–2 μm thick, pale brown to cinnamon brown, echinulate;

germ pores 1–2, equatorial; pedicel hyaline, short, $15\text{--}20 \times 6\text{--}8 \mu\text{m}$. TELIA similar, dark brown to blackish brown, $0.08\text{--}0.1 \times 0.2\text{--}0.8 \text{ mm}$. TELIOSPORES ellipsoid to oblong, rounded at both ends or sometimes attenuated downwards, not or slightly constricted at septum, $25\text{--}32(\text{--}35) \times 19\text{--}22 \mu\text{m}$ (mean $30.4 \times 20.2 \mu\text{m}$); wall $1.5\text{--}2 \mu\text{m}$ thick, smooth, chestnut brown; apex $4\text{--}5 \mu\text{m}$ thick, faintly verrucose with hyaline papilla over germ pores, pale in color; germ pore 1 per cell, pore of upper cell apical, of lower cell at septum, or both slightly subapical; pedicel short, hyaline, deciduous, $24\text{--}30 \times 5\text{--}8 \mu\text{m}$.

MATERIAL EXAMINED: On *Viola caespitosa* D. Don, with II + III stages, Pakistan, Northern Areas, Fairy Meadows, at 3,036 m a. s. l., 12th August, 2007. NSA # G 04. (LAH Herbarium No. NSA 1100).

COMMENTS: *Puccinia violae* has been reported on *Viola biflora* L., *V. canescens* Wall., *V. caespitosa*, *V. indica* W. Becker, *V. rupestris* F.W. Schmidt, and *V. serpens* Wall. from Fairy Meadows, Hazara, Kaghan Valley, Shogran, and



FIGS. I–K: *Puccinia violae* (I). SEM photograph of a telium containing teliospores (J). SEM photograph of teliospores (K). A teliospore showing verrucose wall ornamentation.

Swat State by Ahmad (1956a,b), Jørstad & Iqbal (1967), Ono & Kakishima (1992), Ono (1992), and Kakishima et al. (1993a,b).

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Literature cited

- Ahmad S. 1956a. *Uredinales* of West Pakistan. *Biologia* 2: 29–101.
- Ahmad S. 1956b. Fungi of Pakistan. Biological Society of Pakistan, Lahore Monograph 1: 1–126.
- Ahmad S, Iqbal SH, Khalid AN. 1997. Fungi of Pakistan. Nabiza Printing Press, Karachi, Pakistan.
- Arthur JC, Cummins GB. 1962. Manual of the rusts in United States and Canada. Hafner Publishing Company: New York.
- Cummins GB. 1971. The rust fungi of cereals, grasses and bamboos. Springer Verlag Berlin-Heidelberg-New York.
- Hennen JF, Figueiredo MB, de Carvalho Jr AA, Hennen PG. 2005. Catalogue of the species of plant rust fungi (*Uredinales*) of Brazil. Published online by Instituto de Pesquisas Jardim Botânico do Rio de Janeiro (<http://www.jbrj.gov.br/publica/uredinales/index.htm>).
- Hiratsuka N, Sato S, Katsuya K, Kakishima M, Hiratsuka Y, Kaneko S, Ono Y, Sato T, Harada Y, Hiratsuka T, Nakayama K. 1992. The rust flora of Japan. Tsukuba Shuppankai, Tsukuba.
- Iqbal SH, Afshan NS, Khalid AN, Niazi AR, Sultan A. 2009. Additions to the rust fungi of Fairy Meadows, the Northern Areas of Pakistan. *Mycotaxon* 109: 1–7.
- Jørstad I, Iqbal SH. 1967. *Uredinales* from West Pakistan. *Nytt. Mag. Bot.* 14: 31–38.
- Kakishima M, Izumi O, Ono Y. 1993a. Rust fungi (*Uredinales*) of Pakistan collected in 1991. *Cryptogamic Flora of Pakistan* 2: 169–179.
- Kakishima M, Izumi O, Ono Y. 1993b. Graminicolous rust fungi (*Uredinales*) from Pakistan. *Cryptogamic Flora of Pakistan* 2: 181–186.
- Nüsser M, Dickoré WB. 2000. Flora of Nanga Parbat (NW Himalaya, Pakistan). An annotated inventory of vascular plants with remarks on vegetation dynamics. *Englera* 19: 1–253.
- Ono Y. 1992. *Uredinales* collected in the Kaghan Valley, Pakistan. *Cryptogamic flora of Pakistan* 1: 217–240.
- Ono Y, Kakishima M. 1992. *Uredinales* collected in the Swat Valley, Pakistan. *Cryptogamic flora of Pakistan* 1: 197–216.
- Singh S, Brown L, Bennett-Jones O, Mock J, O'Neil K, Yasmeen S. 2004. Pakistan and the Karakoram Highway. Lonely Planet.
- Sultan MA. 2005. Taxonomic study of rust flora of Northern Areas of Pakistan. Ph.D. Thesis, University of the Punjab. Lahore, Pakistan.
- Troll C. 1939. Das Pflanzenkleid des Nanga Parbat. Begleitworte zur Vegetationskarte der Nanga Parbat-Gruppe (Nordwest-Himalaja), 1: 50,000. Wissenschaftliche Veröffentlichungen des Deutschen Museums für Länderkunde zu Leipzig NF 7: 149–193.
- Wilson M, Henderson DM. 1966. British rust fungi, Cambridge University Press, Cambridge.

A new species of *Gonatophragmium* from Western Ghats, India

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Abstract — The new species *Gonatophragmium mayteni*, characterized by forming necrotic leaf lesions and 1-septate, straight conidia, is described on the endemic host *Maytenus rothiana* (Celastraceae) collected from Mahabaleshwar forests in Maharashtra State, India.

Keys words — fungal diversity, hyphomycetes, taxonomy

Introduction

The present new fungus was collected during the course of an ongoing programme of exploration of fungal diversity and their selective isolation of unusual or rare fungi from the forests of Western Ghats region in India (Singh et al. 2005, 2008; Das et al. 2007; Waingankar et al. 2008).

During the survey, *Maytenus rothiana*, which is an endemic to Central and Maharashtra-Sahyadris of Western Ghats, was found invariably infected with the fungus in question producing eye-catching necrotic symptoms. This fungus, in severe stage, covers 70–75% of the photosynthetic area of an individual leaf (approximate observation). It produces grayish brown to muddy powdery conidial and mycelial masses on the abaxial surface of the leaf lesions in a circular to irregular pattern. Based on olivaceous conidiophores arising from decumbent hyphae forming a complex system of branching and swollen conidiogenous cells bearing flat denticles and single septate subhyaline to pale olivaceous conidia, this collection is accommodated in the genus *Gonatophragmium* Deighton (Deighton 1969, Ellis 1971) and is described and illustrated as new species.

Materials & methods

A Nikon Trinocular Stereozoom microscope (Model SMZ-1500 with Digi-CAM) was used to study growing patterns of colonies on lower leaf surface.

Semi-permanent microscopic slides were prepared by making scrape mounts and sections from an infected portion of the leaves. Thin sections were obtained using a SLEE cryostat microtome. For morphotaxonomical details and photomicrographs an OLYMPUS CX-41 microscope was used. Specimens were mounted in lactophenol-cotton blue for microscopic studies. Measurements of fungal structures were taken with an ocular micrometer. Holotype material is deposited in Ajrekar Mycological Herbarium (AMH), MACS' Agharkar Research Institute, Pune, India (AMH, according to Holmgren et al. 1990).

Attempts to culture the described species on artificial media, especially on V-8 Juice Agar, Potato Dextrose Agar, and Potato Carrot Agar (Tuite 1969) were unsuccessful.

Taxonomic description

Gonatophragmium mayteni S.K. Singh, L.S. Yadav & P.N. Singh, sp. nov.

MYCOBANK MB 514060

(FIGS 1–5)

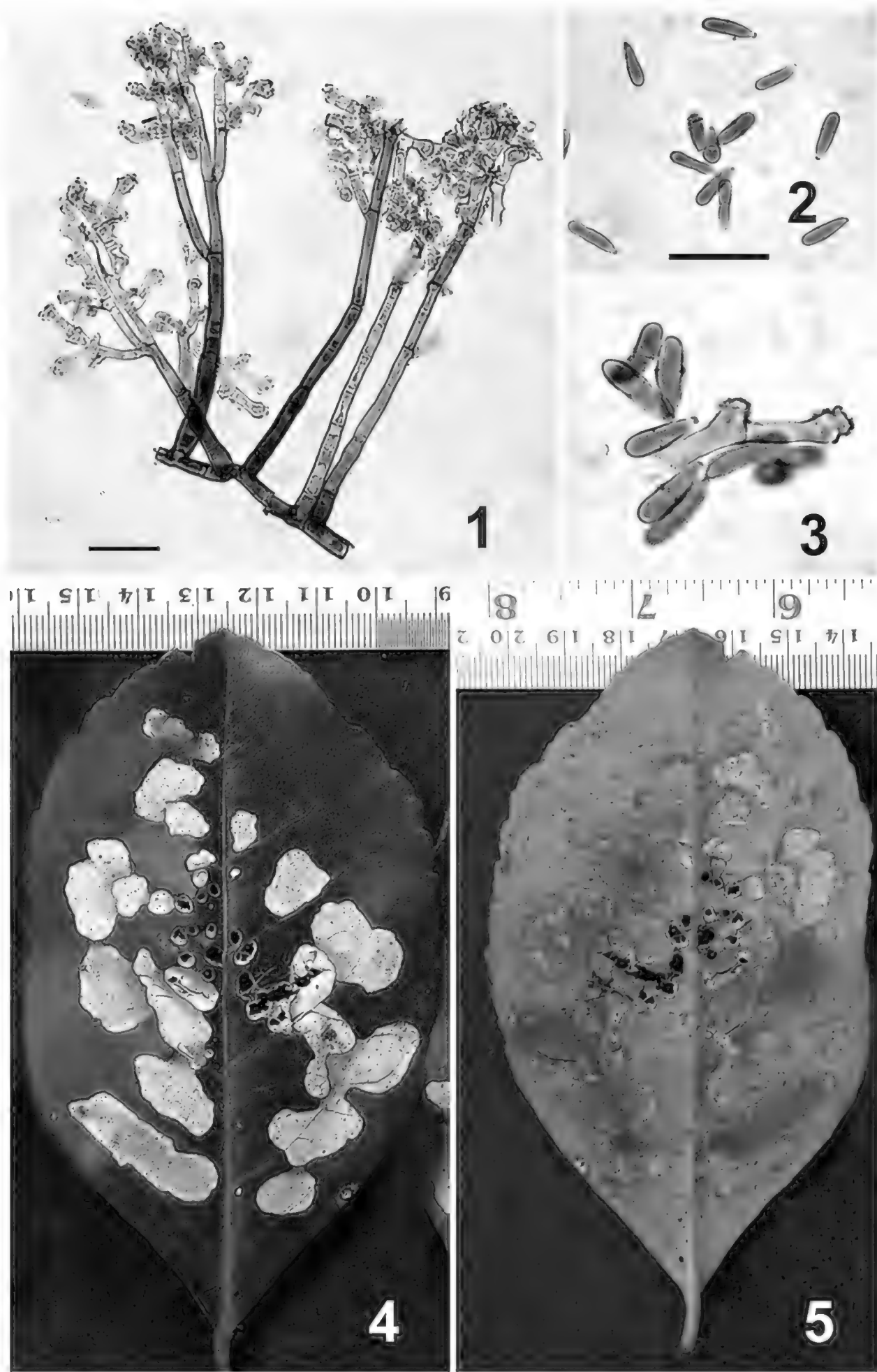
Gonatophragmium epilobii simile, sed conidiophoris latioribus, 3–7 µm, crassitunicatis, conidiis clavatis, cylindratis, subhalinis vel pallide olivaceis et hilis truncatis, leviter incrassatis et fuscatis.

HOLOTYPE – on living leaves of *Maytenus rothiana* (Walp.) Ramamoorthy (*Celastraceae*), India, Lingmala Falls, Mahabaleshwar, Maharashtra, 16 Nov. 2003, S.K. Singh, 9273: AMH.

ETYMOLOGY – *mayteni* refers to the host genus.

Leaf lesions amphigenous, appearing as a single spot or in groups of irregular, necrotic spots, later coalescing to cover large leaf areas, margin grayish white, centre white. Colonies hypophyllous, effuse, powdery, dark brown. Mycelium external, hyphae septate, branched, subhyaline to pale olivaceous, smooth, 3.0–6.5 µm wide. Stromata absent. Conidiophores arising from decumbent hyphae, lateral or terminal, solitary to rarely 2–3 in a group, basal part wider than upper part, macronematous, mononematous, multiseptate, branched, erect, smooth and thick-walled, geniculate, nodose on upper half of the conidiophores subhyaline to olivaceous brown, paler towards the apex, 4–6 transversely septate, 60–110 × 3–7 µm. Conidiogenous cells polyblastic, integrated, terminal to intercalary, swollen, variable in length 12–20 µm long bearing 10–15 loci, cicatrized, scars thickened and darkened, plate-like, about 1 µm in diam. Conidia solitary, holoblastic, dry, acropleurogenous, clavate to rarely cylindrical, straight, rarely curved, always 1-septate, smooth-walled,

FIGS. 1–5. *Gonatophragmium mayteni*. 1. Conidiophores and conidiogenous cells. 2. 1-septate conidia. 3. Magnified view of conidia and part of conidiogenous cells. 4. Leaf showing necrotic lesions (dorsal view). 5. Leaf showing grayish brown to muddy powdery deposition of conidia and conidiophores over the lesions (ventral view). Scale bar = 20 µm.



subhyaline to light olivaceous, apex rounded, base obconicotruncate, hilum thickened and darkened, $6.0\text{--}17 \times 2.0\text{--}3.0 \mu\text{m}$.

NOTES—A survey of literature (Ellis 1971, 1976; Braun & Hill 2002, 2008; Tripathi & Tripathi 2003) revealed that there is no species of *Gonatophragmium* described so far on any members of *Celastraceae*. Morphologically the collection on *Maytenus rothiana* is close to *G. epilobii* U. Braun & C.F. Hill (Braun & Hill 2008), described from New Zealand on *Epilobium ciliatum* (*Onagraceae*), in having exclusively 0–1-septate conidia. But, the present species differs in having clavate or cylindrical, subhyaline to pale olivaceous conidia with thickened and darkened plate like conidial hilum. Furthermore, the conidiogenous cells have 5–15 conidiogenous loci, which are very prominent and thickened in *G. mayteni*, and the conidiophores are much wider ($3\text{--}7 \mu\text{m}$) and have thicker walls. *Gonatophragmium obscurum* U. Braun & C.F. Hill (Braun & Hill 2002) is distinct from *G. mayteni* in having larger, 0–1(–3)-septate, pale olivaceous or pale yellowish brown conidia. *Gonatophragmium mori* (Sawada) Deighton 1969 (Ellis 1971), *G. mangiferae* J.L. Mulder 1973 (Ellis 1976), and *G. kuanense* A.N. Rai (Rai 1996) are quite distinct from *G. mayteni* in having pluriseptate conidia with different shapes. Nine new species of *Gonatophragmium* have been described by Tripathi & Tripathi (2003), but all of them are characterized by having somewhat curved, pluriseptate conidia. The conidia of *G. moracearum* M.S. Tripathi & V. Tripathi 2003 are somewhat narrower than those of *G. mori*, but all other taxa are morphologically barely distinguishable from the latter species, which occurs, according to Ellis (1971), on a wide range of hosts belonging to various families in tropical countries. Without inoculation experiments or molecular data proving that *G. mori* collections on different substrates are host specific and genetically distinct it is difficult to evaluate and recognize the species described by Tripathi & Tripathi (2003). Hence, based on the above-mentioned differences, it is justified to describe the present collection as a new species.

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Literature cited

- Braun U, Hill CF. 2002. Some new micromycetes from New Zealand. *Mycological Progress* 1: 19–30.
- Braun U, Hill CF. 2008. New species and new records of foliicolous hyphomycetes from New Zealand. *Australasian Mycologists* 27(2): 45–56.
- Das K, Singh SK, Calonge FD. 2007. Gasteromycetes of Western Ghats, India: 1. A new form of *Phallus indusiatus*. *Boletín de la Sociedad Micología de Madrid* 31: 135–138.
- Deighton FC. 1969. New genera and species and redispositions of some hyphomycetes, mainly African. *Mycological Paper* 117: 13–30.
- Ellis MB. 1971. Dematiaceous hyphomycetes, CMI, Kew, England.
- Ellis MB. 1976. More dematiaceous hyphomycetes, CMI, Kew, England.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum: part I: The Herbaria of the World. 8th ed. Bronx, NY Botanical Garden.
- Rai AN. 1996. A new species of *Gonatophragmium* from the forest flora of the Indian sub-continent. *Mycological Research* 100: 1263–1264.
- Singh SK, Singh PN, Mishra P. 2005. Contribution to the genus *Polychaeton* from South-West India. *Journal of Mycology and Plant Pathology* 36: 101–103.
- Singh SK, Singh PN, Mishra P. 2008. New species of *Passalora* (cercosporoid hyphomycete) from Western Ghats, India. *Czech Mycology* 60(2): 243–249.
- Tripathi MS, Tripathi V. 2003: New insights in species diversity in genus *Gonatophragmium* Deight. pp. 549–577, in GP Rao et al. (eds), *Frontiers of fungal diversity in India*. International Book Distributing Co. Lucknow.
- Tuite J. 1969. *Plant pathological methods in fungi and bacteria*. Burgess Publishing Company, Minneapolis.
- Waingankar VM, Singh SK, Srinivasan MC. 2008. A new thermophilic species of *Conidiobolus* from India. *Mycopathologia* 165: 173–177.

***Raffaelea quercus-mongolicae* sp. nov.
associated with *Platypus koryoensis* on oak in Korea**

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Abstract — A previously undescribed fungus frequently isolated in Korea from dead oak trees (e.g., *Quercus mongolica*, *Q. aliena*, *Q. serrata*) attacked by the ambrosia beetle, *Platypus koryoensis*, is described as *Raffaelea quercus-mongolicae*. Phylogenetic analysis of 18S rDNA sequences shows the new species to be closely related to *R. quercivora*, a causal agent of oak mortality in Japan, while ITS rDNA and β -tubulin sequence analyses reveal significant differences. *Raffaelea quercus-mongolicae* also differs from *R. quercivora* in conidial shape, associated ambrosia beetle species, geographic origin, and host range.

Key words — *Ambrosiella*, morphology, *Ophiostomatales*, phylogeny, symbiont

Introduction

Since 2004, an unknown fungus has been isolated, most frequently from dead mongolian oak (*Quercus mongolica*), but also (rarely) from *Q. aliena* and *Q. serrata* in the central part of Korea. Kim et al. (2005, 2008) note that the epidemic continues and is spreading southwards. The causal agent is believed to be closely associated with a wood boring ambrosia beetle, *Platypus koryoensis* (Coleoptera: Curculionidae: Platypodidae) in that both fungus and beetle were simultaneously observed from dead or infected oak, and the fungus was also isolated from the beetles (Kim et al. 2005). Male and female beetles, both of which have mycangial cavities adapted for carrying a symbiont fungus, make galleries that serve as entry points for the fungus and which lead directly into the sapwood of the tree (Moon et al. 2008).

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As with most ambrosia beetle-associated symbionts (Batra 1967), the unknown isolates formed sporodochia in beetle galleries that produced conidiophores and conidia morphologically similar to those produced by representatives of the genera, *Raffaelea* and *Ambrosiella* (*Ophiostomatales*). However, it is notoriously difficult to differentiate these two *Ophiostoma*-associated anamorphic genera solely through morphology (Harrington 2005). Previous phylogenetic analysis (Gebhardt et al. 2005) showed that *Raffaelea*-based 18S rDNA sequences are scattered throughout *Ambrosiella*. Thus, Harrington et al. (2008) proposed that *Raffaelea* is the most appropriate name for all ambrosia beetle symbionts with affinities to *Ophiostoma* until the taxonomy of the large genus *Ophiostoma* is resolved. Sequence analysis of the 18S rDNA region showed the Korean isolates embedded within *Raffaelea*. Of the twelve species thus far described in the genus *Raffaelea* (Jones & Blackwell 1998, Kubono & Ito 2002, Harrington et al. 2008), the Japanese fungus *R. quercivora* shares several characters with the present Korean isolates but differs in the associated ambrosia beetle and host plant species and conidial morphology. Although the differences would suggest that the Korean isolates might represent a new *Raffaelea* species, more extensive study was considered necessary before introducing a new taxon.

This paper documents the phenetic characters of the Korean isolates, as well as sequence analyses of the partial 18S rDNA, the completed ITS rDNA, and the partial β -tubulin regions of three selected isolates in comparison with other *Raffaelea* species. In particular, the Korean species is compared with *R. quercivora*, a causal agent of oak mortality in Japan. A new taxon is described and illustrated as *R. quercus-mongolicae*.

Materials and methods

FUNGAL ISOLATES — About one hundred isolates of *Raffaelea* sp. were collected from infected or dead *Quercus mongolica*, *Q. aliena*, and *Q. serrata* trees or from mycangia of *Platypus koryoensis*. Three representative isolates, which are maintained in the Korean Agricultural Culture Collection, Suwon, Korea (KACC), were morphologically and molecularly analyzed in this study. For comparison, two cultures of *R. quercivora* (MAFF410918, MAFF12457) and one of *R. canadensis* (CBS 168.66) were obtained from the National Institute of Agrobiological Resources, Tsukuba, Japan (MAFF) and the Centraalbureau voor Schimmelcultures, the Netherlands (CBS), respectively.

MORPHOLOGICAL ANALYSIS — Microscope slide preparations were examined in bright field and DIC light microscopy, using an Olympus BX51 microscope (Olympus, Tokyo, Japan) for measurements and a Zeiss AX10 microscope (Carl Zeiss, Göttingen, Germany) mainly for photography. Measurements were taken at 1000 \times for conidia and at 100–200 \times for other organs. They are reported as maxima and minima in parentheses, and the mean plus and minus the standard deviation. Means are shown in italic in the centre of the measurements. The surface structure of conidia was observed and

photographed with a Hitachi S-3500N scanning electron microscope. For SEM, the conidiophores and conidia were attached to holders by double-sided adhesive tape and coated with platinum with a Hitachi E-1010 Ion Sputter.

PHYLOGENETIC ANALYSIS — G-DNA was extracted from conidiophores and conidia grown on PDA plates, in accordance with Lee & Taylor (1990). For 18S rDNA amplification and sequencing, primers NS1 and NS6 (White et al. 1990) were employed; ITS1-F (Gardens & Bruns 1993) and ITS4 (White et al. 1990) were used for ITS rDNA regions; T10 and BP12 (Kim et al. 2003) were used for β -tubulin regions. PCR products were purified using QIAquick Gel Extraction Kit (Qiagen, Hilden, Germany) and sequenced on an automatic sequencer (ABI Prism TM 377 DNA Sequencer), using BigDye™ (Applied Biosystems, Foster City, CA, USA) Cycle Sequencing Kit, version 3.1, with the same primers as used for amplification of the three regions.

The newly obtained sequences were edited using DNASTAR computer package (Lasergene, Madison, WI), version 5.05. Sequences were aligned using CLUSTAL X (Thompson et al. 1997). Phylogenetic trees were generated using maximum likelihood (ML) and maximum parsimony (MP) methods. For ML inference, RAxML (Stamatakis 2006) version 7.0.3 was used with all parameters set to default values, using the GTRCAT variant. A MP heuristic search was performed with 1000 random sequence additions and branch swapping by tree bisection-reconnection, using PAUP* version 4b10 (Swofford 2002). For both analyses, the relative robustness of the individual branches was estimated by bootstrapping using 1000 replicates.

Results

Phylogenetic analysis

About 1450 bp of a partial 18S rDNA were amplified and sequenced from each isolate. The Korean isolates and *R. quercivora* showed no large insertion, which had appeared previously in some *Raffaelea* species (Jones & Blackwell 1998). The beginning of ITS1 and end of ITS2, which are significantly conserved, were determined and adjusted by comparing with other *Ophiostomatales* sequences. The phylogenetic relationships between *Raffaelea* isolates were inferred from ML and MP analyses of three data sets of the partial 18S, the complete ITS rDNA, and the partial β -tubulin gene. The results of the phylogenetic reconstructions by ML inference are shown in FIGS. 1-A (18S rDNA), 1-B (ITS rDNA), and 1-C (β -tubulin gene).

In the 18S rDNA alignment, 45 of the 1271 characters were parsimony-informative, and the MP analysis resulted in a most parsimonious tree of 129 steps, with a CI and RI of 0.8295 and 0.8181, respectively. For ITS rDNA alignment, 37 of the 558 characters were parsimony-informative, and the parsimony analysis produced a most parsimonious tree of 126 steps. For β -tubulin gene alignment, 62 of the 881 characters were parsimony-informative, and the parsimony analysis produced a most parsimonious tree of 153 steps. In the latter two trees, both CI and RI were 1.0000. Since no differences were

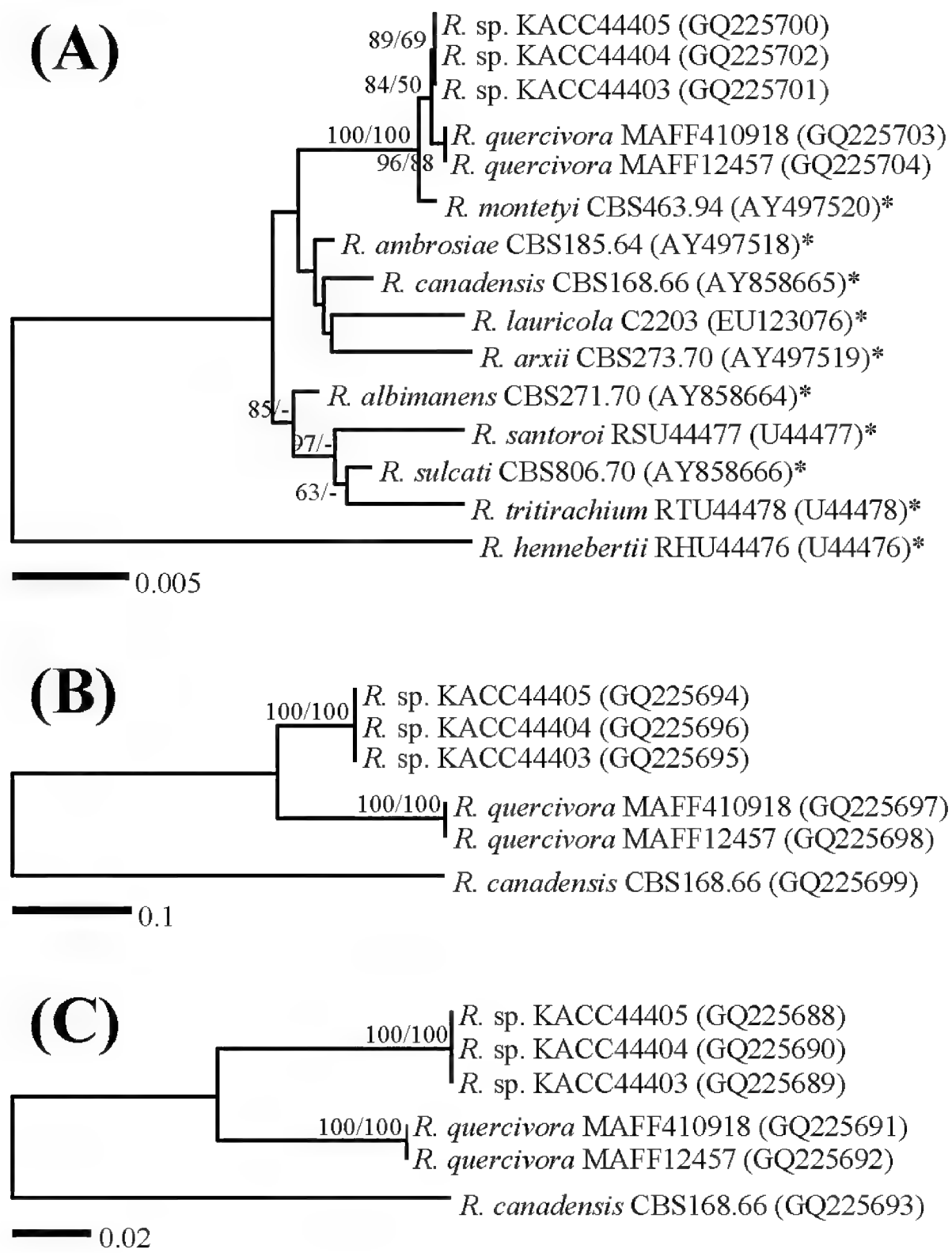


FIGURE 1. Phylogenetic trees of *Raffaelea* species inferred by ML analysis using (A) the partial 18S rDNA, (B) the complete ITS rDNA, and (C) the partial β -tubulin gene. ML and MP bootstrap values above 50 % are given above the branches. The number of nucleotide changes between taxa is represented by branch length and the scale bar equals the number of nucleotide substitutions per site. An asterisk (*) indicates the sequence obtained from GenBank.

found between the ML and MP tree topologies, only the ML trees (with MP analysis support values added) are shown.

The phylogenetic relationships between the Korean isolates and other *Raffaelea* species can only be evaluated from the 18S tree, as neither ITS nor β -tubulin sequence of other *Raffaelea* species were available from GenBank. In the 18S tree, *Raffaelea* sp. (from *Q. mongolica*), *R. quercivora*, and *R. montetyi* formed a group with a high supporting value of 100% in ML and MP analyses, distantly related to other *Raffaelea* species. The first two species were further clustered to a subgroup with moderate ML and MP bootstrap values of 84 % and 50 %, respectively. The phylogenetic distances of “*R. sp.*” to *R. quercivora* were slight; they differed only at two positions out of 1271 nucleotide characters, whereas “*R. sp.*” differed from *R. montetyi* in four positions in 18S rDNA. The ITS rDNA and β -tubulin gene sequence analyses provided higher resolution for comparison than 18S rDNA: “*R. sp.*” and *R. quercivora* formed two distinct groups, and the nucleotide distance between them was significantly high as 7.8 % (37 out of 558 characters were different) in the ITS rDNA and 11.7 % (63 out of 881 characters) in β -tubulin gene.

Morphological analysis

The morphological characteristics of the Korean isolates (“*R. sp.*”) were closest to *R. quercivora* and *R. montetyi*. This is in agreement with the phylogenetic analyses. All three species grow rapidly, form abundant aerial mycelium, and do not produce synnemata. However, they are easily distinguished by conidial size (FIG. 2); the Korean isolates produced conidia that were larger ($4.8\text{--}8.3 \times 2.6\text{--}3.6 \mu\text{m}$) than *R. quercivora* ($3.1\text{--}4.7 \times 2.0\text{--}2.4 \mu\text{m}$) and smaller than *R. montetyi* ($6.6\text{--}13 \times 3\text{--}6.6 \mu\text{m}$). The proposed new *Raffaelea* sp. was also easily separated from *R. montetyi* by the narrow conidial width and inconspicuous annellations at the point of conidial dehiscence.

Taxonomy

Raffaelea quercus-mongolicae K.H. Kim, Y.J. Choi & H.D. Shin, **sp. nov.** FIG. 2

MYCOBANK MB 515072

A *Raffaelea quercivora* conidia grande differt. Socius cum *Platypus koryoensis*.

HOLOTYPE: KOREA. POCHON; Gwangreung Experimental Forest, isolated from discolored sapwood in *Quercus mongolica* Fisch. infested by *Platypus koryoensis* (Murayama), 12 May 2005, K.H. Kim (**Holotype:** KACC44405). Sequences ex-type: GQ225700 for 18S rDNA, GQ225694 for ITS rDNA, and GQ225688 for β -tubulin gene.

ETYMOLOGY: ‘*quercus-mongolicae*’ refers to the scientific name of host plant.

COLONIES on PDA maximum growth at 20–25°C, effuse, growing rapidly, reaching 90 mm diameter in 5 days with uneven white margin, appearing water-soaked and mucilaginous; colonies after 2 weeks turning brown to pale olive,

with a yeasty odor. MYCELIUM aerially abundant, reaching 1 cm high; hyphae branched, septate, hyaline, smooth. CONIDIOPHORES formed in sporodochia or produced separately, hyaline, straight to slightly curved, mostly aseptate, mostly single but rarely branched, smooth, variable in length as (12.5–)14.5–28.3–42.2(–63) μm , but constant in width as 1.5–2.5 μm . CONIDIOGENOUS CELLS terminal, hyaline, smooth, proliferating sympodially or percurrently, with a series of flat, inconspicuous protruding scars or annellations. CONIDIA produced in acropetal order, hyaline, aseptate, smooth, thin-walled, obovoid to pyriform or oblong, (4–)4.8–6.6–8.3(–10) μm long, (2.2–)2.6–3.1–3.6(–4.0) μm wide, length/width ratio = (1.33–)1.64–2.09–2.55(–3.33), tapered markedly toward the base, apex rounded, base truncate.

HABITAT: Associated with *Platypus koryoensis* on living or dead stems of *Quercus mongolica*, *Q. aliena* Blume, and *Q. serrata* Thunb.

ADDITIONAL ISOLATES EXAMINED: KOREA, Seoul, Mt. Surak, from *Quercus mongolica*, 19 Jan 2007, K.H. Kim (KACC44404); KOREA, Goyang, from *Q. mongolica*, 14 Feb 2007, K.H. Kim (KACC44403).

Discussion

Raffaelea quercus-mongolicae, an ambrosia fungus closely associated with *Platypus koryoensis*, has recently contributed to significant mongolian oak mortality in Korea. The isolates were morphologically and molecularly closer to *R. quercivora* than to other *Raffaelea* species, but several distinct characteristics allowed the separation between the two species.

Conidial morphology has been commonly used in *Raffaelea* taxonomy (Scott & Toit 1970, Sutton 1975, Kubono & Ito 2002), and in this study it has also helped discriminate *R. quercus-mongolicae* from *R. quercivora*. Morphologically, the Korean isolates were easily distinguished from Japanese ones by the larger conidia. Based on 18S rDNA phylogenetic analyses, *R. quercus-mongolicae* is distinct from all other *Raffaelea* species except *R. quercivora*. The ITS rDNA and β -tubulin regions, however, show significant sequence divergences between the two species, thus further supporting an independent taxonomic position for *R. quercus-mongolicae*.

A different ambrosia beetle species is associated with each *Raffaelea* species: *Platypus koryoensis* with *R. quercus-mongolicae* and *P. quercivorus* with *R. quercivora*. This correlates with the geographic distribution of the two ambrosia beetles; *Platypus koryoensis* is commonly found in Korea but is not yet known in Japan, while *P. quercivora*, which occurs in east and southeast Asia, is not currently known in Korea. Although Gebhardt et al. (2004) suggested the possibility of ambrosia fungi switching between beetle species, many previous studies have demonstrated that an ambrosia beetle might be highly associated with only a single fungus, which appears to be the case for the species-specific

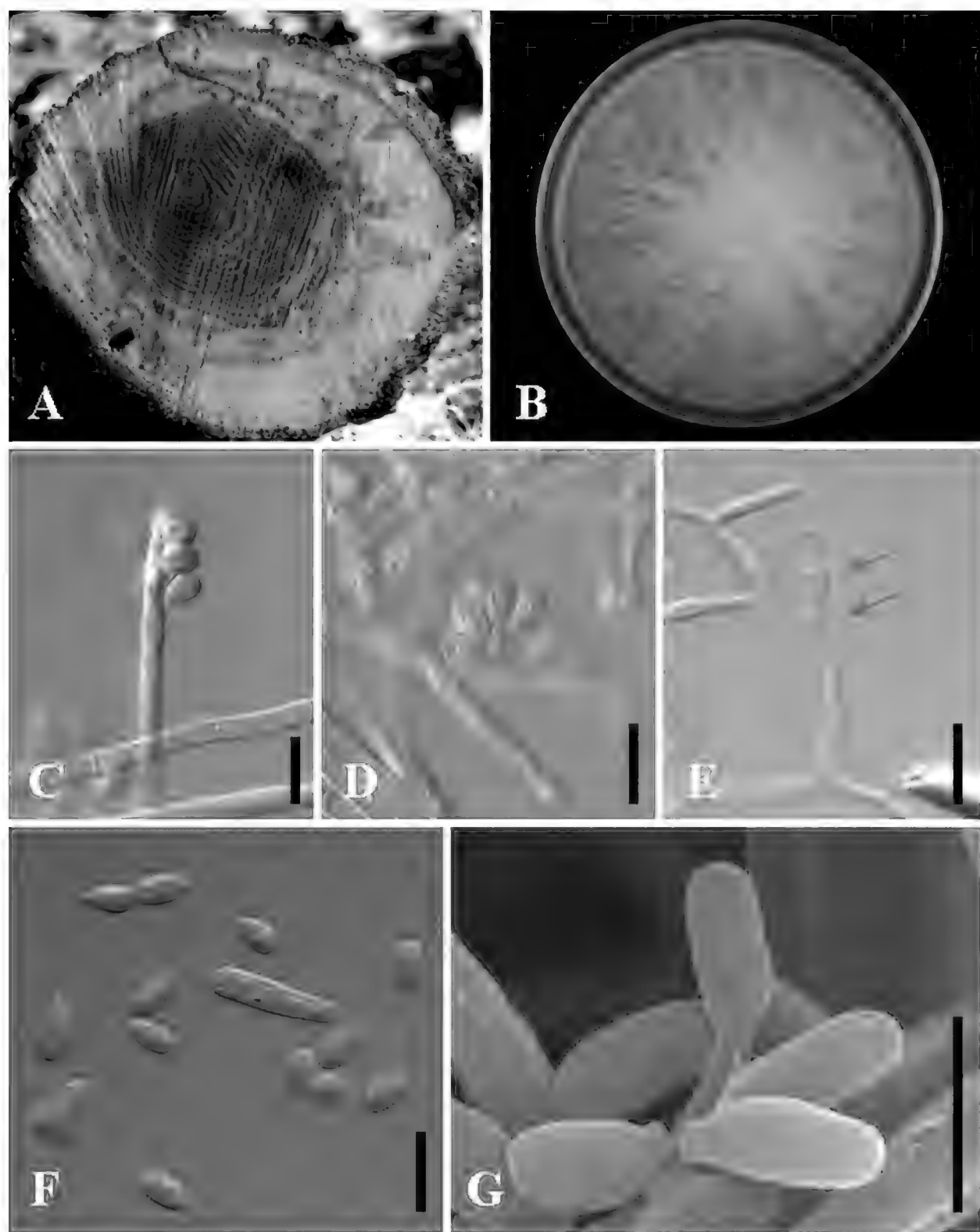


FIGURE 2. *Raffaelea quercus-mongolicae* on *Quercus mongolica*. A: Cross section of *Quercus mongolica* infested by *Platypus koryoensis*, showing necrosis (arrow); B: Colony with sporulation after 5 days of incubation at 25°C on PDA; C & D: Conidiogenous cell with sympodial proliferation and conidia; E: Conidiogenous cell with a series of flat cicatricial scars (arrow); F & G: Conidia. Scale bars = 10 µm for C-F and 5 µm for G.

association of *R. quercus-mongolicae* and *R. quercivora* with their respective ambrosia beetles.

The host plant range also differs, with the Korean species isolated mainly from *Quercus mongolica* (only rarely from *Q. aliena* and *Q. serrata*) and the Japanese species isolated from *Q. serrata* and *Q. crispula*. This coincides with the host plant geographic distribution, as *Quercus mongolica* is widely distributed over central Korea while the *R. quercivora* hosts, *Q. serrata* and *Q. crispula*, are restricted to southern Korea.

The ambrosia beetle, *P. koryoensis*, was first recorded from Korea in 1930 (Hong et al. 2006), but until now the oak mortality and its associated fungus have never been reported. The “oak death” may be closely related to recent global warming, which has allowed ambrosia beetles to extend their distribution range in Korea, as Kamata et al. (2002) noticed for Japan.

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Literature cited

- Batra LR. 1967. Ambrosia fungi: a taxonomic revision and nutritional studies of some species. *Mycologia* 59: 976–1017.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes – application to the identification of mycorrhizae and rusts. *Mol. Ecol.* 2: 113–118.
- Gebhardt H, Begerow D, Oberwinkler F. 2004. Identification of the ambrosia fungus of *Xyleborus monographus* and *X. dryographus* (Coleoptera: Curculionidae, Scolytinae). *Mycol. Prog.* 3: 95–102.
- Gebhardt H, Weiss M, Oberwinkler F. 2005. *Dryadomyces amasae*: a nutritional fungus associated with ambrosia beetles of the genus *Amasa* (Coleoptera: Curculionidae, Scolytinae). *Mycol. Res.* 109: 687–696.
- Harrington TC. 2005. Ecology and evolution of mycophagous bark beetles and their fungal partners. In: Vega FE, Blackwell M, eds. *Insect-fungal associations: Ecology and evolution*. Oxford University Press, New York. pp. 257–292
- Harrington TC, Fraedrich SW, Aghayeva DN. 2008. *Raffaelea lauricola*, a new ambrosia beetle symbiont and pathogen on the *Lauraceae*. *Mycotaxon* 104: 399–404.
- Hong KJ, Kwon YD, Park SW, Lyu DP. 2006. *Platypus koryoensis* (Murayama) (Platypodidae; Coleoptera), the vector of oak wilt disease. *Korean J. Appl. Entomol.* 45(2): 113–117.
- Jones KG, Blackwell M. 1998. Phylogenetic analysis of ambrosial species in the genus *Raffaelea* based on 18S rDNA sequences. *Mycol. Res.* 102: 661–665.
- Kamata N, Esaki K, Kato K, Igeta Y, Wada K. 2002. Potential impact of global warming on deciduous oak dieback caused by ambrosia fungus *Raffaelea* sp. carried by ambrosia beetle *Platypus quercivorus* (Coleoptera: Platypodidae) in Japan. *Bull. Entomol. Res.* 92: 119–126.

- Kim JJ, Kim SH, Lee S, Breuil C. 2003. Distinguishing *Ophiostoma ips* and *Ophiostoma montium*, two bark beetle-associated sapstain fungi. FEMS Microbiol. Lett. 222: 187–192.
- Kim KH, Kim CS, Lee SK, Park IK, Kim JK, Lee JK, Kwon YD. 2005. Etiology, ecology and control of oak wilt disease in Korea. Research Reports of Korea Forest Research Institute. 2005: 630–656.
- Kim KH, Seo ST, Lee SG, Oh E, Lee SH, Choi W, Choi KS, Park IK, Shin SC, Shin JH. 2008. Oak wilt disease in Korea. Pests & Disease Report No. 08-12. Korea Forest Research Institute, Seoul, Korea.
- Kubono T, Ito S. 2002. *Raffaelea quercivora* sp. nov. associated with mass mortality of Japanese oak, and the ambrosia beetle (*Platypus quercivorus*). Mycoscience 43: 255–260.
- Lee SB, Taylor JW. 1990. Isolation of DNA from fungal mycelia and single spores. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ, eds. PCR protocols: a guide to methods and applications. Academic Press, San Diego, CA, USA. pp. 282–287.
- Moon MJ, Park JG, Oh E, Kim KH. 2008. External microstructure of the ambrosia beetle *Platypus koryoensis* (Coleoptera: Curculionidae: Platypodidae). Entomol. Res. 38: 202–210.
- Scott DB, du Toit JW. 1970. Three new *Raffaelea* species. Trans. Br. Mycol. Res. 55: 181–186.
- Sutton BC. 1975. Two undescribed hyphomycetes from Malaysia. Antonie van Leeuwenhoek 41: 179–184.
- Stamatakis A. 2006. RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. Bioinformatics 22: 2688–2690.
- Swofford DL. 2002. PAUP: phylogenetic analysis using parsimony (*and other methods). Version 4b10. Sinauer Associates, Sunderland, Massachusetts.
- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The Clustal X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Res. 24: 4876–4882.
- White TJ, Bruns T, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ, eds. PCR protocols: a guide to methods and applications. Academic Press, San Diego, CA, USA. pp. 315–322.

***Racocetra beninensis* from sub-Saharan savannas: a new species in the *Glomeromycetes* with ornamented spores**

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Abstract — A new fungal species is described under the epithet *Racocetra beninensis* (*Racocetraceae*, *Glomeromycota*). It forms white to creamy-white, globose to sub-globose (sometimes oval) glomerospores terminally on sporogenous cells. Spores measure 195–335 µm diam and have two spore walls: a three-layered outer wall and a three-layered inner wall. The outer spore surface is ornamented with rounded wart-like projections that measure 0.9–2.8 × 0.9–3.8 µm and are spaced (2.2–)4.0–11.0 µm apart. The germination shield that forms on the outer surface of the inner wall is multiple-lobed (6–10 lobes) and (sub-)hyaline or occasionally yellowing with age. The lobes regularly bear a single germ tube initiation. The fungus differs from other *Racocetra* species by spore size and color, ornamentation type, and outer spore wall staining reaction. It has been frequently recovered from sites under natural vegetation and newly cultivated or post-harvest yam (*Dioscorea* spp.) fields in the sub-Saharan Sudan and Guinea savannas of Benin (West Africa).

Key words — arbuscular mycorrhizal fungi, *Gigasporaceae*, *Scutellospora*

Introduction

Arbuscular mycorrhizal fungi (AMF) appear particularly prevalent in tropical savannas (e.g. Sieverding 1989; Tchabi et al. 2008, 2009), where species

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representing the sub-order *Gigasporineae* sensu Morton & Benny (1990) appear most abundant (Maia & Trufem 1990, Oehl et al. 2007, Mathimaram et al. 2007, Goto et al. 2009). In a recent study of AMF diversity of sub-Saharan West Africa, for example, a high diversity of species belonging to *Gigasporineae* J.B. Morton & Benny were recovered from soils in natural savannas and newly cultivated yam (*Dioscorea* spp.) fields (Tchabi et al. 2008). Several of these species have since been transferred to the newly established family *Racocetraceae* Oehl et al. (Oehl et al. 2009), including some regarded as new species (Tchabi et al. 2009). One such undescribed species was first cited as *Scutellospora* sp. WAS1 in Tchabi et al. (2008) and later as *Racocetra* sp. WARA1 in Tchabi et al. (2009). This species, which presented a unique spore wall structure consisting of a conspicuous warty surface ornamentation, is herewith described under the name *Racocetra beninensis*.

Material and methods

Study area and sites

Soils were sampled from 27 natural, fallow, and cultivated sites, located within the Sudan (SU), Northern Guinea (NG), and Southern Guinea savanna (SG) ecological zones in Benin, sub-Saharan West Africa. The climate follows a gradient from SG through NG to SU of decreasing annual rainfall and an increasingly long dry season from 5 to 8 months (Tchabi et al. 2008). The SG has two wet and two dry seasons per annum, while NG and SU are monomodal. The vegetation consists of trees, shrubs and grasses with tree and shrub prominence decreasing from south to north (e.g. Adjakidje 1984, Adjanohoun 1989, Tchabi et al. 2008). The soils are dominantly ferruginous Ferralsols. The selected sites were either natural savannas or yam fields established in the first year after (forest) savanna clearance, mixed cropping systems, groundnut and intensively managed cotton. Sites located in long-term fallows (≥ 7 years old) were also included to compare species present in undisturbed sub-Saharan savannas with those present in restored fallows and under varying levels of cropping intensification and soil disturbance.

Soil sampling and culturing of AM fungi

Soils were sampled as described in Tchabi et al. (2009) towards the end of the 2004 wet season in September/October and during the subsequent dry season in February 2005. Soil pH, organic carbon, and available phosphorus were determined using standard methods (Tchabi et al. 2008, 2009).

The spore material used for this study derived from field samples. Extensive attempts were made to propagate the AMF species present in the field samples through 'bait' cultures with various hosts (e.g., *Brachiaria humidicola* (Rendle) Schweick., *Stylosanthes guianensis* (Aubl.) Sw., *Sorghum bicolor* (L.) Moench, *Dioscorea cayenensis* Lam., *D. rotundata* Poir). Several bait culture systems were established (Tchabi et al. 2008, 2009) inoculating 5–10% field soils to autoclaved substrate (Terragreen: Quartz sand mixture; 3:1 [wt/wt]). The AMF communities were cultivated for 8–24 months and the host plants periodically analyzed for mycorrhizal infection and AMF spore formation.

The 'bait culturing' resulted in the reproduction of 45 AMF species from ~250 pots, but the species described below was not reproduced (Tchabi et al. 2009). Thus, the present species description is restricted to morphological analyses of spores recovered directly from field samples.

Morphological analyses

Glomerospores extracted from field soils by wet sieving and sucrose centrifugation (Brundrett et al. 1994) were mounted in PVLG, PVLG + Melzer's reagent, and water (Spain 1990, Brundrett et al. 1994). Terminology used in the species description and spore denomination follows Oehl et al. (2009) and Goto & Maia (2006) respectively.

Spore wall ornamentation was compared with that observed in spores in type specimens of other *Racocetra* species; the six species examined were *R. coralloidea* (Trappe et al.) Oehl et al. 2009 [holotype OSC #31'026; paratype OSC #31'025], *R. gregaria* (N.C. Schenck & T.H. Nicolson) Oehl et al. 2009 [holotype OSC #36'518], *R. intraornata* B.T. Goto & Oehl 2009 [holotype URM 79247; isotype OSC #134'506, Z+ZT Myc 775], *R. minuta* (Ferrer & R.A. Herrera) Oehl et al. 2009 [IBACC isotype 7 Herrera/Ferrer-HAC], *R. persica* (Koske & C. Walker) Oehl et al. 2009 [holotype OSC #45'837], and *R. verrucosa* (Koske & C. Walker) Oehl et al. 2009 [holotype OSC #45'838; paratype OSC #45'846].

Taxonomy

Racocetra beninensis Oehl, Tchabi & Lawouin, sp. nov.

FIGS. 1–12

MYCOBANK MB 515027

Sporocarpia ignota. Sporae singillatim in solo efformatae anguste adiacetae ad cellulas sporogeneas subterminales vel intercalares, albae ad ochro-albae, globosae (210–320 μm in diametro) vel subglobosae vel ovaes (195–280 \times 220–335 μm); sporae tunica duabus: tunica exterior stratis tribus, in totum 6.5–13.2 μm crassa; stratum exterius tunicae exterioris hyalinum, semi-persistens ad persistens, 1.2–2.2 μm crassum, cum verrucis rotundibus vel ovalibus, 0.9–2.1(–2.8) $\mu\text{m} \times$ 0.9–3.8 μm , (2.2–)4.0–11.0 μm in distancia; stratum medium laminatum, album ad ochro-album, 4.5–11.0 μm crassum; stratum interius tunicae exterioris album ad ochro-album, 0.7–1.4 μm crassum; tunica exterior flavum vel fusco-flavum (ad flavo-fuscum) colorans reagente Melzeri; tunica interior de novo formans stratis tribus hyalinibus; tunica interior tribus stratis, 5.4–8.7 μm crassa in totum; tunica interior non colorans reagente Melzeri; scutellum germinale in superficie exteriori tunicae interioris, hyalinum ad subhyalinum ad albo-flavum; ovale vel ellipsoidum vel ovoidum, 95–135 \times 110–150 in diameter, lobatum, paucioribus (6–10) lobis depressionibusque germinationis; structurae mycorrhizarum et cellulae auxiliares ignotae. Holotypus: 85-8501 (Z+ZT Myc 1627).

TYPE: 85-8501 (Z+ZT Myc 1627, **holotype**) from soil samples of a natural savanna in the Southern Guinea Savanna (SG) in Savè, Benin (07°45'74"N; 02°27'52E).

ETYMOLOGY: *beninensis*, referring to the country in West Africa where the species was first recovered.

GLOMEROSPORES are singly formed in soils terminally on a sub-terminal or intercalary bulbous suspensor cell (= 'sporogenous' cell; FIGS. 1–2). Glomerospores are white to light ochre, occasionally becoming a light cream colour with age, globose (210–320 μm in diameter) to sub-globose, infrequently

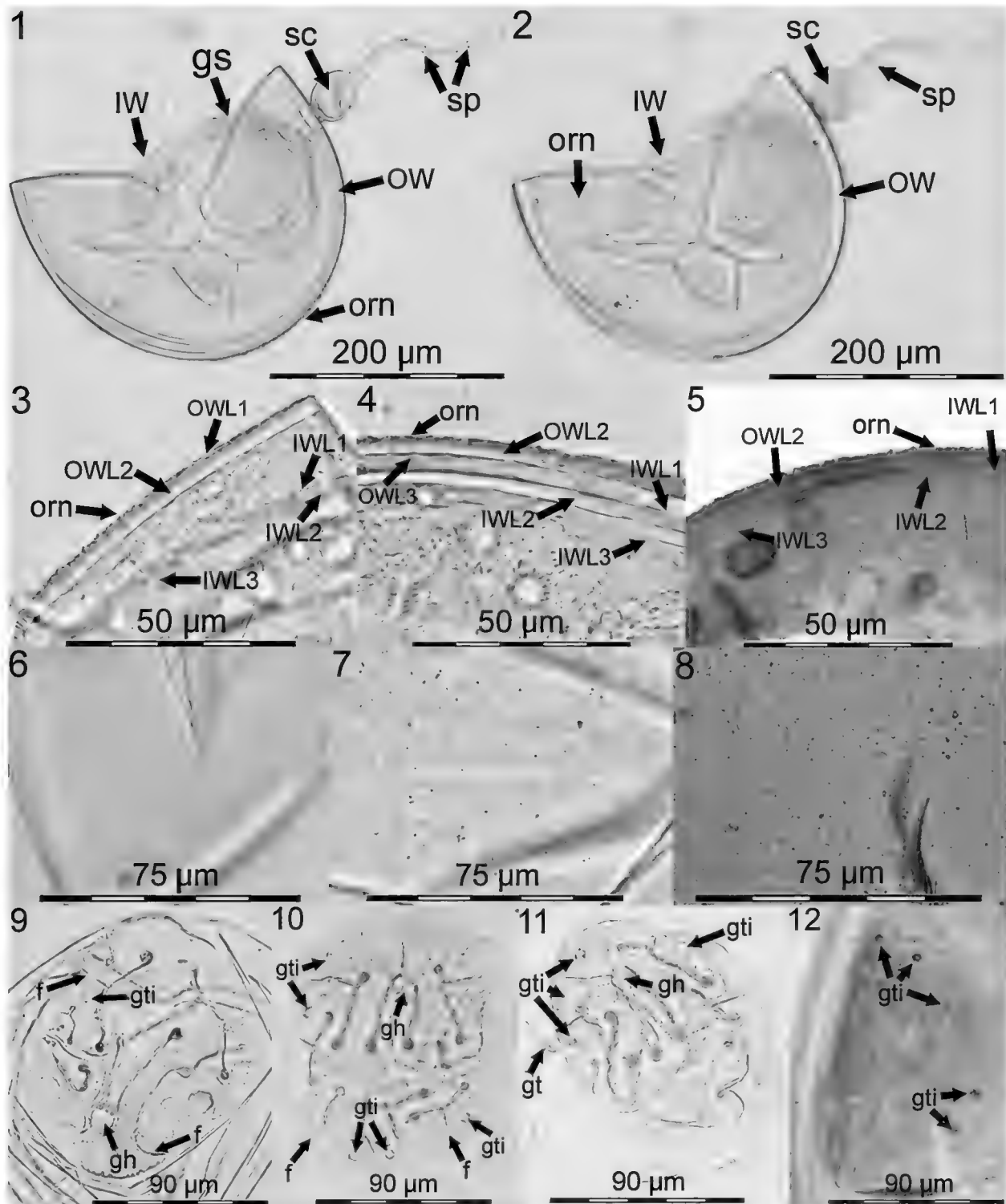
oval ($195\text{--}280 \times 220\text{--}335\ \mu\text{m}$) and have two walls: an outer and an inner wall (ow and iw; Figs. 1–5). Sporocarp formation is unknown.

OUTER WALL is white to light ochre-white, occasionally becoming light creamy with age, in total $6.5\text{--}11.0\ \mu\text{m}$ thick and consists of three layers (OWL1–3; Figs. 3–7). Outermost layer (OWL1) is hyaline to sub-hyaline, semi-persistent to persistent and $1.2\text{--}2.4\ \mu\text{m}$ thick (Figs. 3–4). The outer surface is adorned with wart-like projections that are $0.9\text{--}2.1\text{--}(2.8)$ long, $0.9\text{--}3.8\ \mu\text{m}$ wide, rounded to oval in planar view and $(2.2\text{--})4.0\text{--}11.0\ \mu\text{m}$ apart (Figs. 3–8). The second layer (OWL2) is white to light ochre-white, sometimes becoming light cream when old, $4.5\text{--}11.0\ \mu\text{m}$ thick (Figs. 3–4). OWL3 is concolorous with OWL2, or slightly lighter in color, $0.7\text{--}1.4\ \mu\text{m}$ thick but often difficult to observe as closely adherent to laminate OWL2 (Figs. 3–5). OWL1 may stain light yellow to yellow in Melzer's reagent while OWL2 and OWL3 readily stain bright yellow to dark yellow to yellow-brown in Melzer's (Figs. 5, 8). The straight pore channel on the ow at the connection with the sporogenous cell is about $3.1\text{--}5.5\ \mu\text{m}$ broad and often closed by a plug formed by spore wall material of OWL2, but sometimes appears to be open.

INNER WALL is three-layered (Figs. 3–5) bearing a germination shield on the outer surface (Figs. 1–2, 9–12), $5.4\text{--}8.7\ \mu\text{m}$ thick in total. Outer layer of the inner wall (IWL1) is hyaline, semi-flexible to unite and $1.2\text{--}2.4\ \mu\text{m}$ thick. Second layer (IWL2) is finely laminate, $2.8\text{--}5.5\ \mu\text{m}$ thick. Innermost layer (IWL3) is $0.9\text{--}1.5\ \mu\text{m}$ thick, (semi-)flexible and, as it tends to tightly adhere to IWL2, can be difficult to detect. The three layers may slightly expand in PVLG based mountants. The iw does not stain in Melzer's reagent.

SPOROGENOUS CELL (sc) is formed terminally or intercalary, globose to elongate, concolorous with the spore, or occasionally bright yellow to yellow brown in older spores, $37\text{--}56\ \mu\text{m}$ long and $34\text{--}48\ \mu\text{m}$ in diameter (Figs. 1–2). Two wall layers are generally visible on sc being continuous with OWL1 and OWL2. OWL1 on the sporogenous cell is $0.7\text{--}1.4\ \mu\text{m}$ and semi-persistent; persistent OWL2 is $2.2\text{--}3.9\ \mu\text{m}$ thick. Warty-projections were never observed on sc surface. The sporogenous cell hypha attached is $12\text{--}20\ \mu\text{m}$ broad and also bi-layered, tapering to $5\text{--}9\ \mu\text{m}$ within $200\text{--}350\text{--}(500)\ \mu\text{m}$ distance from sc. The sporogenous hyphal wall is concolorous with the sporogenous cell wall, sometimes lighter yellow in color, and tapers from $1.2\text{--}2.2\ \mu\text{m}$ to $0.9\text{--}1.4\ \mu\text{m}$ within this distance. Several (3–8) septa originating from the inner layer (OWL2) may be visible in the hypha (Figs. 1–2).

GERMINATION SHIELD is hyaline to sub-hyaline (Figs. 9–11), infrequently light yellow in aged spores (FIG. 12), oval to ellipsoid or ovoid, $95\text{--}135 \times 110\text{--}150\ \mu\text{m}$ in diameter, and generally has 6–10 lobes (Figs. 8–10), which are difficult to differentiate when the shield is not readily observed in planar view (FIG. 12).



FIGS. 1–12. *Racocetra beninensis*. FIGS. 1–2. Spore with sporogenous cell (sc), two walls (ow and iw), a germination shield (gs) on iw, and a wart-like ornamentation (orn) on the surface (FIG. 2). Sporogenous hypha with several septa (sp). FIGS 3–5. Spore wall structure in cross view with three-layered ow (OWL1–3) and three-layered iw (IWL1–3); ow stains yellow brown in Melzer's reagent (Fig. 5). FIGS. 6–8. Wart-like projections on ow in planar view, variable in size and distance between each other; ow dark yellow in Melzer's (Fig. 8). FIGS. 9–12. Multiple-lobed germ shields in various developmental stages. FIG. 9. Young shield with initial germ hole (= germ pore); germ tube initiations (gti) still barely visible; large folds (f) separate the lobes. FIGS. 10–11. Mature shields with several gti in focus, from where 1–2 germ tubes (gt) emerge during germination. FIG. 12. Old shield of a degrading spore; shield contents slightly darkened; gti significantly darkened and clearly visible.

Large folds (~10–50 µm long) arise from the shield wall separating the lobes (FIGS. 9–12). The one-layered shield wall and the folds are hyaline to sub-hyaline and generally only 0.8–2.1 µm thick. Each lobe may bear one rounded germ tube initiation (gti, FIGS. 9–12), 2.9–5.5 µm in diameter. The gti may remain undetectable in young spores (FIG. 9), becoming increasingly visible with age of spores, being easily observed in mature spores (FIGS. 10–12).

SPORE DEVELOPMENT — The key stages of spore development could be deduced from clearly identified spores of *R. beninensis*, recovered from soil sampled from the field on different occasions. First the outer spore wall differentiates into one evanescent to semi-persistent outer layer (OWL1) with its randomly dispersed, wart-like projections, the laminate layer (OWL2), and the adherent thin inner layer (OWL3). The three-layered inner wall (IW) develops de novo without visible connection with the outer wall. Finally, the germination shield differentiates its multiple-lobed structure, beginning from the initial germ hole (= germ pore) and forming a gti at the end of the shield development in each of the lobes; from there the germination tubes emerge during initial germination.

GERMINATION — One to two germ tubes may arise. They are light yellow to bright yellow, 5–7 µm in diameter and emerge from one or two gti's (FIG. 11). Germ tubes directly penetrate the ow and branch then almost immediately in the soil environment. The mono- to bi-layered germ tube walls are ~1.2–2.0 µm thick in close spore vicinity.

AUXILIARY CELLS — unknown.

MYCORRHIZA FORMATION — unknown.

DISTRIBUTION — *Racocetra beninensis* is so far known only from sub-Saharan savannas of Benin. The new fungus was found at 13 of 27 total collection sites, including 8 (of 10) natural savanna vegetation sites, 4 (of 5) yam fields, and one (of 3) fields cropped to mixed maize and groundnut (TABLE 1). It was not recovered from the 3 monocropped groundnut field soils cultivated in the third year of continuous cropping, the 3 intensively managed cotton fields in the fourth year after forest clearance, or from the 3 7-year old fallows (Tchabi et al. 2008). Geographical locations and selected soil physico-chemical parameters of the 13 productive sites are given in TABLE 1.

ADDITIONAL SPECIMENS EXAMINED: **BENIN. Southern Guinea Savanna (SG). Savè:** Isotype specimens (85-8502, 85-8503, 85-8504, 85-8505, 85-8506) deposited at Z+ZT (Z+ZT Myc 1627), **BENIN. Southern Guinea Savanna. Okpara:** paratype specimens (85-8507, 85-8508) deposited at OSC (OSC #134,713); **BENIN. SG. Ikoko:** paratypes (85-8511, 85-8512) deposited at Z+ZT, paratypes (85-8521, 85-8522) deposited at FB (Freiburg, Germany); **BENIN. SG. Zogbodomey:** paratypes (85-8523, 85-8524) deposited at URM. Further paratype specimens from 13 sites of SU, NG, and SG (TABLE 1).

TABLE 1 Geographic and soil data for *Racocetra beninensis* isolation sites

ECOLOGICAL ZONE Sampling sites	GEOGRAPHIC LOCATION	pH (H ₂ O)	ORGANIC C G KG ⁻¹	AVAILABLE PHOSPHORUS MG KG ⁻¹	
				(NA- ACETATE)	(CITRATE)
SUDAN SAVANNA					
Natural Savanna 1	10°56'N; 01°32'E	6.1	13.9	47.6	69.9
Natural Savanna 2	10°08'N; 01°56'E	6.5	23.8	3.9	8.7
Yam field 1	10°08'N; 01°51'E	5.9	11.6	3.9	8.7
Maize&groundnut mix	10°19'N; 01°35'E	6.2	6.4	7.4	13.1
NORTHERN GUINEA SAVANNA					
Natural Savanna 3	08°43'N; 02°40'E	6.6	9.3	8.7	8.7
Natural Savanna 4	09°03'N; 02°04'E	6.7	36.0	46.3	65.5
SOUTHERN GUINEA SAVANNA					
Natural Savanna 5	07°46'N; 02°28'E	6.7	9.9	14.8	34.9
Natural Savanna 6	07°57'N; 02°26'E	7.2	13.9	8.7	13.1
Natural Savanna 7	07°35'N; 02°19'E	6.4	13.9	28.4	43.6
Natural Savanna 8	08°20'N; 01°51'E	6.5	20.3	28.8	34.9
Yam field 2	07°49'N; 02°15'E	6.1	9.3	8.7	8.7
Yam field 3	07°55'N; 02°11'E	6.7	16.8	10.9	13.1
Yam field 4	08°20'N; 01°51'E	6.2	6.4	6.5	8.7

Racocetra species with ornamentations on the spore surface

Five other *Racocetra* species have spore surface projections (TABLE 2). The spores of these species are more heavily pigmented — yellow to yellow-brown or orange-brown, to red-brown to dark brown to black (FIGS. 13–21, TABLE 2; Gerdemann & Trappe 1974, Nicolson & Schenck 1979, Ferrer & Herrera 1981, Koske & Walker 1985). Moreover, in *R. coralloidea*, *R. gregaria*, *R. verrucosa*, and *R. persica* the spore surfaces are densely crowded with variously shaped and sized papillae or wart-like projections (FIGS. 13–20, TABLE 2). In *R. minuta*, the projections have a central depression on the apex (Ferrer & Herrera 1981, FIG. 21).

Discussion

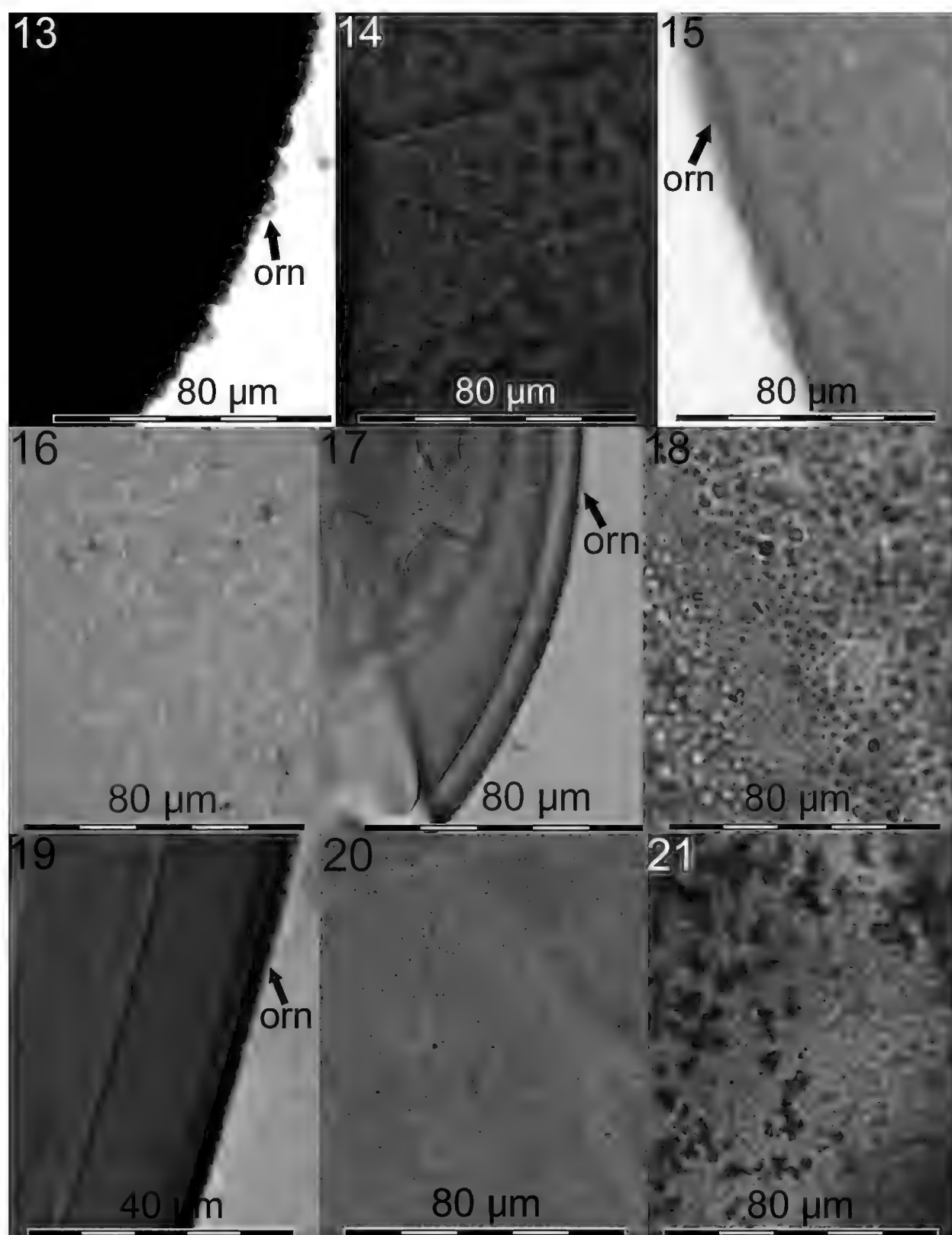
Racocetra beninensis is easily distinguished from all other known species in the genus by spore size and color, ornamentation type, and the different outer wall (ow) staining reaction. The ten species attributed to *Racocetra* are characterized by bi-walled spores and a multi-lobed, hyaline to rarely light yellow germination shield on iw and, as far as it is known, by a more or less intensive ow staining reaction in Melzer’s (TABLE 2; Oehl et al. 2009). Four species lack ornamentation: *R. fulgida* (Koske & C. Walker) Oehl et al.,

TABLE 2 Spore characters in *Racocetra* species with projections on the spore outer wall (OW) surfaces

SPECIES	SPORE SIZE (µm)	SPORE COLOR	OUTER WALL: Thickness; Color in Melzer's	PROJECTIONS (µm): Diam. × height [Distance between]
<i>R. beninensis</i>	195–280 × 220–335	White to light ochre	6.5–11 µm; Bright yellow to yellow brown	0.9–3.4 × 0.9–2.5 [(2.5)4.5–11]
<i>R. coralloidea</i>	300–400 × 320–460	Very dark brown to black	8–15 µm; Black	0.5–6 × 1.5–2.5 [0.5–2.0]
<i>R. gregaria</i>	250–450 × 250–480	Dark brown to dark red-brown	6–9 µm; Dark brown	3–12 × 1–10 [0.5–1.8]
<i>R. minuta</i>	95–180	Dark brown to opaque	5.5–8.5 µm; Unknown	1.9–3.0 × 2.5–3.9 [4.0–6.0]
<i>R. persica</i>	270–360 × 280–390	Pinkish orange to brown-orange	2.5–11 µm; Dark red-brown	0.4–0.6 × 0.3–0.6 [0.5–1.0]
<i>R. verrucosa</i>	220–480 × 220–480	Straw yellow to orange-brown	5–16 µm; Dark red-brown	0.5–1.5 × 0.5–1.5 [0.5–1.5]

R. castanea (C. Walker) Oehl et al., *R. alborosea* (Ferrer & R.A. Herrera) Oehl et al., and *R. weresubiae* (Koske & C. Walker) Oehl et al. (Ferrer & Herrera 1981, Koske & Walker 1986, Walker et al. 1993, Oehl et al. 2009). One species, *R. intraornata*, has tuberculate projections on the inner ow surface (Goto et al. 2009). The remaining species (i.e., *R. coralloidea*, *R. gregaria*, *R. minuta*, *R. persica*, *R. verrucosa*, *R. beninensis*) are all characterized with projections on the outer spore surface (FIGS. 11–19, TABLE 2). In *R. persica*, the surface of the pinkish-orange to brown-orange spores is crowded with fine papillae (Koske & Walker 1985), while the surfaces of the brown *R. gregaria* and almost black *R. coralloidea* spores are densely crowded with rounded or coralloid warts (Gerdemann & Trappe 1974, Nicolson & Schenck 1979, Koske & Walker 1985, Oehl et al. 2009). *Racocetra verrucosa* is distinguished by its (straw) yellow to yellow-brown spores that are crowded with wart-like projections that are usually smaller than those in *R. gregaria* and *R. coralloidea* but more prominent than in *R. persica* (Koske & Walker 1985, Oehl et al. 2009). Beside *R. beninensis*, only *R. minuta* has spores that are not densely packed with projections on the outer surface. However, their brown spores have regularly sized, equidistant projections that have conspicuous central depressions at their apex (Ferrer & Herrera 1981). Finally, *R. beninensis* is similar in color (white to creamy white) with only *R. fulgida*, which does not display any ornamentation.

In the new species a short peg often forms on the sporogenous cells (FIGS. 1–2). We interpret such pegs as aborted hyphae but have called this type of sc formation intercalary. As the hyphae never exceeded 15–20 µm in length,



FIGS. 13–21. Types of spore surface ornamentation in *Racocetra* (cross and planar views). FIGS. 13–14. *R. coralloidea*. FIGS. 15–16. *R. gregaria*. FIGS. 17–18. *R. verrucosa*. FIGS. 19–20. *R. persica*. FIG. 21. *R. minuta*.

we do not know whether they continue as branching mycelial hyphae or form another sc a short distance from the previous, as seen in *Gigaspora ramisporophora* Spain et al. 1989.

Racocetra beninensis was regularly recovered from natural sub-Saharan savannas in all three ecological zones surveyed in Benin. It also frequented yam fields during the first year after savanna clearance but was less frequent in traditional maize/groundnut mixed cropping systems in the second year of agricultural production. The fungus was not observed or recovered from field soil later in the cropping cycle, i.e. the rhizosphere of traditionally grown groundnut or from intensively managed cotton fields.

The fungus did not appear to restore during long-term fallows that followed the 5–7-year agricultural cycle (Tchabi et al. 2008). In conclusion, along with several other species of the *Gigasporineae* (e.g. *Scutellospora calospora* (T.H. Nicolson & Gerd.) C. Walker & F.E. Sanders 1986 and *Cetraspora pellucida* (T.H. Nicolson & N.C. Schenck) Oehl et al. 2009; Jansa et al. 2002, Oehl et al. 2003, 2005), *R. beninensis* appears negatively affected by soil disturbance mediated through agricultural intensification. Its existence may consequently be seriously threatened in the sub-Saharan tropics through intensifying agricultural practices caused by increasing land pressure.

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Literature cited

- Adjakidje V. 1984. Contribution à l'étude botanique des savanes guinéennes de la République Populaire du Bénin – Thèse du troisième cycle, Université de Bordeaux III, Bordeaux
- Adjanonhoun EJ. 1989. Contribution aux études ethnobotaniques et floristiques en République Populaire du Bénin. Agence de Coopération Culturelle et Technique, Paris
- Brundrett M, Melville L, Peterson L. 1994. Practical methods in mycorrhizal research. Mycologue Publications, University of Guelph, Guelph, Ontario.
- Ferrer RL, Herrera RA. 1981 [1980]. El genero *Gigaspora* Gerdemann et Trappe (*Endogonaceae*) en Cuba. Rev. Jardin. Bot. Nacional Habana 1: 43–66.
- Gerdemann JW, Trappe JM. 1974. The *Endogonaceae* in the Pacific Northwest. Mycologia Memoir No. 5. 76 pp.
- Goto BT, Maia LC. 2006. Glomerospores: a new denomination for the spores of *Glomeromycota*, a group molecularly distinct from *Zygomycota*. Mycotaxon 96: 129–132.
- Goto BT, Silva GA, Maia LC, Oehl F. 2009. *Racocetra intraornata*, a new species in the *Glomeromycetes* with a unique spore wall structure. Mycotaxon 109: 483–491.
- Jansa J, Mozafar A, Anken T, Ruh R, Sanders IR, Frossard E. 2002. Diversity and structure of AMF communities as affected by tillage in a temperate soil. Mycorrhiza 12: 225–234.
- Koske RE, Walker C. 1985. Species of *Gigaspora* (*Endogonaceae*) with roughened walls. Mycologia 77: 702–720.

- Koske RE, Walker C. 1986. Species of *Scutellospora* (*Endogonaceae*) with smooth-walled spores from maritime sand dunes: Two new species and a redescription of the spores of *Scutellospora pellucida* and *Scutellospora calospora*. *Mycotaxon* 27: 219–235.
- Maia LC, Trufem SFB. 1990. Vesicular-arbuscular mycorrhizal fungi in cultivated soils in Pernambuco State, Brazil. *Rev Bras Bot* 13: 89–95.
- Mathimaran N, Ruh R, Jama B, Verchot L, Frossard E, Jansa J. 2007. Impact of agricultural management on arbuscular mycorrhizal fungal communities in Kenyan Ferralsol. *Agric Ecosyst Environ* 119: 22–32.
- Morton JB, Benny GL. 1990. Revised classification of arbuscular mycorrhizal fungi (*Zygomycetes*). A new order, *Glomales*, two new suborders, *Glomineae* and *Gigasporineae*, and two new families, *Acaulosporaceae* and *Gigasporaceae*, with an emendation of *Glomaceae*. *Mycotaxon* 37: 471–491.
- Nicolson TH, Schenck NC. 1979. Endogonaceous mycorrhizal endophytes from Florida. *Mycologia* 71: 178–198.
- Oehl F, de Souza FA, Sieverding E. 2009 [‘2008’]. Revision of *Scutellospora* and description of five new genera and three new families in the arbuscular mycorrhiza-forming *Glomeromycetes*. *Mycotaxon* 106: 311–360.
- Oehl F, Sieverding E, Ineichen K, Mäder P, Boller T, Wiemken A. 2003. Impact of land use intensity on the species diversity of arbuscular mycorrhizal fungi in agroecosystem of Central Europe. *Appl Environ Microbiol* 69: 2816–2824.
- Oehl F, Sieverding E, Ineichen K, Ris E-A, Boller T, Wiemken A. 2005. Community structure of arbuscular mycorrhizal fungi at different soil depths in extensively and intensively managed agroecosystems. *New Phytol* 165: 273–283.
- Oehl F, Sieverding E, Wiemken A. 2007. History and biogeography of arbuscular mycorrhizal fungi – a global view. In: Maia LC, Malosso E, Yano-Melo AM (eds) *Micologia – avanços no conhecimento*. 5° Congresso Brasileiro de Micologia, 11–16 November 2007, Recife, Brazil, pp. 256–258.
- Sieverding E. 1989. Ecology of VAM fungi in tropical agrosystems. *Agric. Ecosyst. Environ.* 28: 369–390.
- Spain JL 1990. Arguments for diagnoses based on unaltered wall structures. *Mycotaxon* 38: 71–76.
- Spain JL Sieverding E, Schenck NC. 1989. *Gigaspora ramisporophora*: a new species with novel sporophores from Brazil. *Mycotaxon* 34: 667–677.
- Tchabi A, Burger S, Coyne D, Hountondji F, Lawouin L, Wiemken A, Oehl F. 2009. Promiscuous arbuscular mycorrhizal symbiosis of yam (*Dioscorea* spp.), a key staple crop in West Africa. *Mycorrhiza* 19: 375–392.
- Tchabi A, Coyne D, Hountondji F, Lawouin L, Wiemken A, Oehl F. 2008. Arbuscular mycorrhizal fungal communities in sub-Saharan savannas of Benin, West Africa, as affected by agricultural land use intensity and ecological zone. *Mycorrhiza* 18: 181–195.
- Walker C, Gianinazzi-Pearson V, Marion-Espinasse H. 1993. *Scutellospora castanea*, a newly described arbuscular mycorrhizal fungus. *Cryptogamie* 14: 279–286.

A new *Boletus* from North America

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Abstract — *Boletus roodyi* is described as new to science. It appears to be mycorrhizal with *Quercus* and is widely distributed from central West Virginia to Arkansas and eastern Texas.

Key words — *Boletaceae*, ectomycorrhizal fungi, taxonomy

Introduction

Boletus roodyi sp. nov. is characterized by its blood red to pinkish-purplish red pileus, yellow hymenophore, smooth stipe stained with red, and lack of bluing reaction in any parts. It has a wide, though disjunct, distribution from central West Virginia – from Taylor County in the north to McDowell County in the south – to eastern Arkansas and far eastern Texas close to the border with Louisiana. It is associated with *Quercus* and appears most similar to *Boletus rubissimus* A.H. Sm. 1973 from Michigan, which differs in its smaller basidiospores, apically reticulated stipe, and bluing hymenophore and flesh.

Materials and methods

Macroscopic descriptions are based on fresh and dried specimens, field notes and color photographs. Color terms are approximations, while capitalized color terms in parentheses are from Ridgway (1912). Numerical color designations are from Kornerup & Wanscher (1978). Macrochemical reactions were determined using 10% NH₄OH and 5% KOH. Microscopic structures were observed with an Olympus BH-2 compound microscope; freehand sections of dried fungal material were rehydrated in 70% ETOH and mounted in H₂O, 3% KOH and Melzer's reagent. In the description of basidiospores, *n* = number measured,

followed by the mean spore lengths and widths \pm their standard deviations and the Q_m value, which represents the mean Q value \pm its standard deviation; Q = mean length/width ratio. Herbarium acronyms are from Holmgren et al. (1990).

Taxonomic description

Boletus roodyi B. Ortiz, D.P. Lewis & Both, sp. nov.

FIGS. 1, 2

MYCOBANK: 513384

Pileus rubrosanguineus, subtomentosus, siccus, 50–160 mm latus. Contextus albus vel pallide luteus, immutabilis. Tubi flavi, demum olivaceo-viridi, pori concolores, non contusi. Stipe pallide flavus supra, rubro maculatus infra medium. Basidiosporae 9.5–16.2 \times 3.6–4.5 μ m.

TYPE: W.C. Roody, 27 Aug 1998, Teter Creek Lake, Barbour Co., West Virginia, USA (Holotype Both 4499 BUF, Isotype CFMR).

ETYMOLOGY: in honor of William C. Roody, its discoverer and collector of the holotype, consummate field biologist, mycologist and photographer, author of “Mushrooms of West Virginia and the Central Appalachians” and co-author of three major books on macrofungi of North America.

ICONES: NAB-16, NAB-17 (Bessette et al. 2000: 363)

PILEUS 50–160 mm broad, convex to plano-convex to plane, in age at times with upturned marginal areas and then plano-concave, when immature with a faint whitish pruina, dry, glabrous to faintly velutinous to subtomentose, becoming rimose-areolate in age; uniformly red, “Dragon’s Blood Red” to “Pompeian Red” (9C7), pinkish red to rose red (10C5), or blood red (10C7–8), as dark as “Etruscan Red” (near 9E5 to 10E7) or ruby red (12C-D6); margin at first incurved, becoming decurved, sterile, narrowly projecting, yellow. FLESH very pale yellow to nearly white, with a very narrow red line under the pileipellis, not changing color when exposed or developing reddish stains in some. ODOR not distinctive (but strongly cumarinous as dried). TASTE mild to slightly astringent. TUBES adnate to narrowly depressed, 5–10 mm long, “Lemon Chrome” (3A5) to pale golden yellow (4A5), becoming more greenish yellow (3A4–5), in age greenish-olivaceous, darkening to yellow-orange when bruised; PORES somewhat angular, 1–2 mm broad, concolorous with tubes. SPORE DEPOSIT brownish-olivaceous. STIPE 50–110 mm long, 10–25 mm broad, equal most of its length but tapered at the base, glabrous to finely pruinose; pale golden yellow in apical area, paler yellow downward (2A3), irregularly streaked, mottled or flecked red-concolorous with pileus mainly in the lower half of stipe, in some only so at the base; basal mycelium white. FLESH whitish to very pale yellow, golden yellow in larval tunnels, red in the base at times, unchanging when exposed.

BASIDIOSPORES 9.5–16.2 \times 3.6–4.5 μ m ($n = 20$, $13.26 \pm 2.60 \times 4.16 \pm 0.46$; $Q_m = 3.17 \pm 0.40$), fusoid, smooth, with grayish yellow or greenish yellow



FIG. 1. Basidiomata of *Boletus roodyi*, Both 4597 (BUF).

contents in KOH; inamyloid, dextrinoid, or with pale grayish blue contents in Melzer's. BASIDIA $21.6\text{--}26.1 \times 6.3\text{--}7.2 \mu\text{m}$, clavate, (1-2) 4-sterigmate, hyaline or with yellowish contents in KOH, with golden yellow, yellowish brown or dextrinoid contents in Melzer's. BASIDIOLES $14.4\text{--}27.9 \times 7.2\text{--}9 \mu\text{m}$, clavate. PLEUROCYSTIDIA $35.1\text{--}53.1 \times 7.2\text{--}10.8 \mu\text{m}$, ventricose-rostrate or fusoid-ventricose, hyaline in KOH, few, smooth and thin-walled. CHEILOCYSTIDIA $18\text{--}36.9 (41.4) \times 5.4\text{--}10 \mu\text{m}$, versiform, fusoid-ventricose, fusoid, fusoid-mucronate or clavate, occasionally one-septate, hyaline or with yellow or yellowish brown contents in KOH, smooth and thin-walled. PILEIPELLIS a tangled layer of repent hyphae $2.7\text{--}5.9 \mu\text{m}$ broad, contents coral red in H_2O , becoming yellow to grayish yellow in KOH; grayish yellow to yellowish brown in Melzer's; end cells cylindrical. PILEUS TRAMA hyphae moderately loosely interwoven, $4\text{--}9 \mu\text{m}$ broad, hyaline in KOH, yellowish brown to dextrinoid in Melzer's, smooth, thin-walled. HYMENOPHORAL TRAMA boletoid, divergent, grayish yellow in KOH; yellow, golden yellow or yellowish brown in Melzer's, in mass occasionally with a fleeting amyloid reaction; lateral strata elements $2.7\text{--}5.4 \mu\text{m}$ broad, loose; mediostratum $18\text{--}36 \mu\text{m}$ wide, parallel hyphae $4.5\text{--}15.3 \mu\text{m}$ broad. STIPITIPELLIS hyphae $3.6\text{--}16.2 \mu\text{m}$ broad, subparallel to interwoven, hyaline in KOH, orange yellow to dextrinoid in Melzer's.

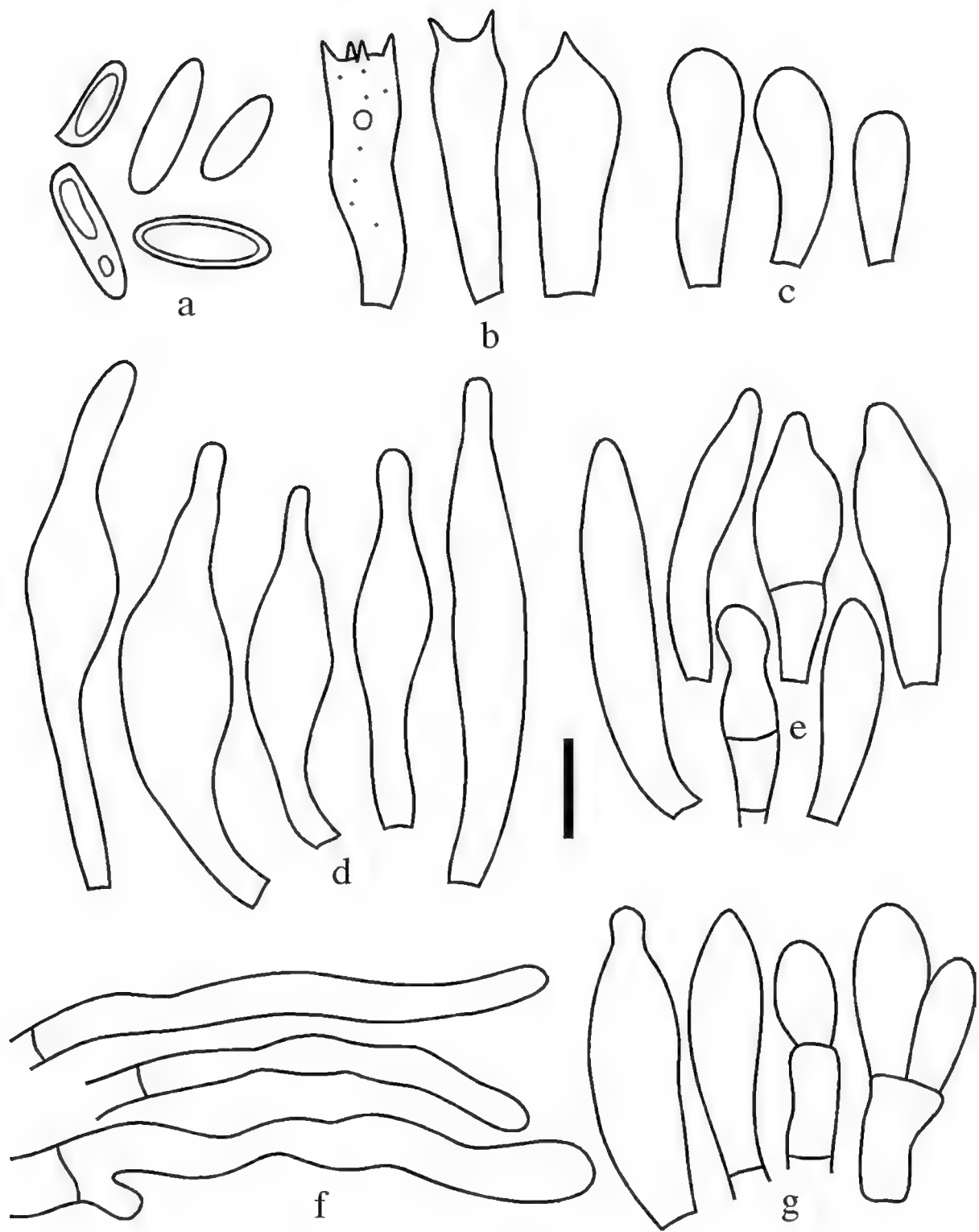


FIG. 2. Microscopic features of *Boletus roodyi*, HOLOTYPE, Both 4499 (BUF).
a. Basidiospores. b. Basidia. c. Basidioles. d. Pleurocystidia. e. Cheilocystidia.
f. Elements of the pileipellis. g. Caulocystidia. Scale bar = 10 μ m.

CAULOCYSTIDIA 16.7–31.5 \times 5.4–9 μ m, clavate, occasionally with a mucronate or capitate apex, in clusters (fasciculate), hyaline in KOH, with yellow or golden yellow contents in Melzer's, thin-walled. CLAMP CONNECTIONS absent. MACROCHEMICAL REACTIONS: NH_4OH and KOH on pileus surface produce a slate-blue flash that quickly changes to yellow ocher. KOH on context pale bluish, on tubes bluish green fading to a lighter shade; on stipe surface NH_4OH

and KOH dingy amber; NH₄OH on dried pileus surface dark red, bleaching to very pale pink.

ECOLOGY, RANGE, AND DISTRIBUTION: Gregarious to scattered, rarely caespitose, with various species of oak (*Quercus alba*, *Q. coccinea*, *Q. rubra* in West Virginia; *Q. alba*, *Q. michauxii*, *Q. nigra* in Texas), in mixed woods of oak and pine (*Pinus strobus*, *P. taeda*), or oak, hickory and beech; from central West Virginia to eastern Arkansas and eastern Texas; fruiting from late June to mid-September.

ADDITIONAL MATERIAL EXAMINED: USA. **ARKANSAS:** Perry Co. LAKE SYLVIA CAMPGROUND, 16 Jul 2005, D.P. Lewis (*Lewis* 7265) (BUF, CFMR). **WEST VIRGINIA:** Barbour Co. TETER CREEK LAKE 10 Aug 2001, W.C. Roody (*Both* 4548) (BUF, CFMR); 4 Jul 2004, D. Mitchell (*Both* 4598) (BUF); McDowell Co. PANTHER STATE FOREST, 22 Jul 2002, W.C. Roody, (*Both* 4597) (BUF). **TEXAS:** Hardin Co. BIG THICKET NATIONAL PRESERVE, JACK GORE BAYALL UNIT, 26 Jul 1985, D.P. Lewis (*Lewis* 3882) (F); 19 Sep 1987, D.P. Lewis (*Lewis* 4075) (F); Newton Co. BLEAKWOOD, GROUNDS OF LEWIS RESIDENCE, 262 CR 3062 and State Highway 87, 25 June 2000, D.P. Lewis (*Lewis* 6296) (BUF, F); 1 Jul 1996, D.P. Lewis (*Lewis* 5675) (F); 22 June 2003, D.P. Lewis (*Lewis* 6696) (BUF, CFMR); Orange Co. VIDOR, GROUNDS OF OUR LADY OF LOURDES CATHOLIC CHURCH, off FM105, 29 June 1982, D.P. Lewis (*Lewis* 3113) (SFSU); Tyler Co. BIG THICKET NATIONAL PRESERVE, BEECH CREEK UNIT, 1 Jul 1982, D.P. Lewis (*Lewis* 3147) (F); 14 Jul 2006, D.P. Lewis (*Lewis* 7525) (BUF). Ten collections from nine counties in West Virginia were deposited by W.C. Roody in the Davis Elkins College Herbarium (DEWV). These were not examined by the authors but are assumed to be conspecific.

COMMENTARY: In their section “Undescribed Bolete Species,” Bessette et al. (2000) provided two views of a group of three specimens of *Boletus roodyi* (as NAB 16 and NAB 17), stating that “this species appears to be a member of the *Boletus speciosus* or *Boletus regius* group and seems closest to *Boletus rubissimus* Smith.” Indeed, Smith (1973) placed *B. rubissimus* in stirps *Regius* of *Boletus* and compared it with *B. peckii* Frost 1878, *B. pseudopeckii* A.H. Sm. & Thiers 1971, *B. regius* Krombh. 1832, and *B. speciosus* Frost 1874, exactly where Singer (1977) placed it (in his section *Appendiculati*), but without including *B. peckii*, which he placed in section *Calopodes* because of its bitter taste. While *Boletus roodyi* shares overall colors with *B. rubissimus*, it differs in the lack of a reticulum, the non-bluing context, the white (instead of yellow) mycelium around the base of the stipe and the larger spores (9–16.5 × 3.6–4.5 vs. 9–11 × 3–4 μm).

The lack of any bluing or reticulum, the adnate (to narrowly depressed) tubes, and the pruinosity of at least the immature stage would place *B. roodyi* in section *Subpruinosi* in Singer’s (1986) classification and where Peck (1900) placed his *Boletus roseotinctus* from North Carolina, a species that has not been reported since. The description by Peck could easily apply to *Boletus roodyi*: “Pileus broadly convex to nearly plane, firm, dry, pruinose, pink or pale rosy red, flesh yellowish white; tubes short, adnate, yellowish, their mouths minute, subround, the dissepiments even, stem equal, even, yellow above, red or purple

red below; spores oblong, $10\text{--}12 \times 4\text{--}5 \mu\text{m}$, pileus about 5 cm broad, July and August.” Snell (1934), who examined Peck’s material at Albany, noted “that there were specimens there larger than the dimensions given by Peck” and believed that he had collected it but did not provide any details. Murrill (1909) and Coker & Beers (1943) treated *B. roseotinctus* as a synonym of *B. peckii*, but Snell (1934) disagreed with Murrill’s disposition since *B. peckii* was “characterized by a reticulate stipe and whitish flesh changing to blue, while *B. roseotinctus* has an even, furfuraceous stipe and unchanging flesh. Unfortunately, the type of *Boletus roseotinctus* appears to be lost and no other collections are known to exist (Both 1993).

Boletus roodyi also bears some resemblance to *Boletus bicolor* Peck 1872 and its relatives in *Stirps Sensibilis* of *Boletus*, Subsection *Fraterni* in the classification of Smith & Thiers (1971). Among these are the red colors of the pileus, the yellow stipe with red tones, and the short tubes. However, *B. roodyi* differs in the lack of any bluing reaction and in the stable red pigments of its pileus. The red pigment in the pilei of *B. bicolor*, *B. miniato-olivaceus* Frost 1874, and *B. carminipes* A.H. Sm. & Thiers 1973 appears to be unstable since it gradually pales with age being replaced by yellow to olivaceous tones.

The single collection of *B. roodyi* from Arkansas of four caespitose specimens is very similar to collections from West Virginia, but the stipes are nearly entirely pale yellow except for the very base which is red. The collections from Texas are more slender and the pilei have more vinaceous red colors, while the red stains on the stipes are more irregular and not primarily confined to the lower half of the stipe.

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Literature cited

- Bessette AE, Roody WC, Bessette AR. 2000. North American boletes: a color guide to the fleshy pore mushrooms. Syracuse University Press, USA.
- Both EE. 1993. The boletes of North America. A compendium. Buffalo Museum of Science. Buffalo, New York, USA.
- Coker WC, Beers AH. 1943. The Boletaceae of North Carolina. University of North Carolina Press, Chapel Hill, USA.
- Holmgren PK, Holmgren NH, Barner, LC. 1990. Index Herbariorum, part I: the herbaria of the world. Reg Veg 120: 1–693. <http://sweetgum.nybg.org/ih/>.
- Kornerup A, Wanscher JH. 1978. Methuen handbook of colour. 3rd ed., reprinted. Eyre Methuen Ltd., London. 252 pp.
- Murrill WA. 1909. The *Boletaceae* of North America-II. Mycologia 1: 140–160.

- Peck CH. 1900. New species of fungi. Bull.Torrey Bot. Club 27: 609–613.
- Ridgway R. 1912. Color standards and color nomenclature. Washington, D.C. Published by the author. 53 color plates.
- Singer R. 1977. Key for the identification of the species of *Agaricales* I. Sydowia 30: 92–279.
- Singer R. 1986. The *Agaricales* in modern taxonomy. 4th ed. Koeltz Scientific Books, Koenigstein (Germany).
- Smith AH. 1973. Notes on Michigan *Boletaceae*. Persoonia 7(2): 321–331.
- Smith AH, Thiers HD. 1971. The boletes of Michigan. University of Michigan Press, Ann Arbor, USA.
- Snell WH. 1934. Notes on boletes III. Mycologia 26: 348–359.

***Psilachnum staphyleae*, a new member of foliicolous *Hyaloscyphaceae* from Korea**

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Abstract — An interesting hyaloscyphaceous species was found on fallen leaves of *Staphylea bumalda*. The fungus fit well within the concept of *Psilachnum*. It is distinguished from other members of the genus by the almost sessile apothecia and foliicolous habit. We describe it as a new species, *Psilachnum staphyleae*.

Key words — *Ascomycota*, *Helotiales*, species nova, taxonomy

Introduction

The genus *Psilachnum* Höhn. is a small group of *Hyaloscyphaceae* that comprise species with minute apothecia possessing cylindric, smooth-walled hairs, cylindric to narrowly lanceolate paraphyses, and ellipsoid to fusoid small ascospores. Since Höhn (1926) erected this genus approximately 27 species have been recorded worldwide (Dennis 1978, Huhtinen 1987, Sharma 1988, Galan & Raitviir 1999, Zhuang et al. 2002, Raitviir 2004).

In the investigation of Korean discomycetes, an interesting *Psilachnum* species was found on fallen leaves of bumalda bladdernut (*Staphylea bumalda* DC.), a deciduous shrub distributed only in Eastern Asia, China, Korea, and Japan. This vernal fungus belongs to *Psilachnum* but differs from all known species of the genus in the almost sessile apothecia and foliicolous habit.

Materials and methods

Fresh material was primarily mounted in distilled water to observe the natural color of the microstructures. Dried material was revived in 3% aqueous KOH. Amyloid reactions were tested by Melzer's reagent (MLZ) or Lugol's solution

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(IKI). Measurements were made in Lacto-Cotton Blue (CB). Line drawings were made with the aid of an Olympus BX50 microscope equipped with a drawing tube. The microscopic photographs were taken by a digital camera (AxioCam MRc5) mounted on a DIC microscope (Zeiss AX10). Specimens studied have been deposited in the Korea University Herbarium, KUS.

To obtain pure cultures, fresh apothecia were attached to the lid of a Petri dish facing down to eject their ascospores onto the 50% diluted PDA media containing streptomycin sulfate (S6501-100G, Sigma-Aldrich). Germinating spores were carefully transferred to the nutrient-rich media such as CMA, MEA, and PDA, using a stereomicroscope (Olympus SZ40). They were incubated for 10 weeks at 25°C under 12 hour-alternative fluorescent light conditions. Cultures were deposited in the Korea Agricultural Culture Collection, KACC.

Description

Psilachnum staphyleae J.G. Han, M.J. Park & H.D. Shin, sp. nov.

FIGURES 1–3

MYCOBANK MB 515080

Apothecia dispersa vel gregaria, breviter stipitata usque ad subsessilia, primo subglobosa, dein cupulata vel applanato-cupulata, 1 mm diametro, disco cremeo vel bubalino, receptaculo cremeo usque ad pallide cinnamomeo, sicca albido vel cremeo, piloso. Excipulum ectale ex textura prismatica compositur, cellulis hyalinis, tenuiter, tunicatis, 9–11.5 × 4.5–8 µm. Pili cylindracei, apicibus angustatis acutis, septati, tenuiter hyalinotunicati, laeves, 20–56 × 2–3.5 µm. Asci non uncinati, cylindraceo-clavati, octospori, 33–46 × 4–5 µm, poro MLZ+. Sporae biseriatae vel oblique uniseriatae, hyalinae, anguste clavato-fusoideae, interdum anguste cylindraceo-fusoideae, rectae vel minute curvatae, aseptatae, biguttulatae, (5.5–)5.7–7.2(–8) × (1–)1.1–1.4(–1.6) µm. Paraphyses lanceolatae, ascos 12–21 µm superantes, 2.5–4 µm in diametro.

In foliis putridis Staphyleae bumaldae crescit. Species foliicola apotheciis subsessilis distincta.

HOLOTYPE – on damp rotting leaves of *Staphylea bumalda*, Experimental Forest of Kangwon National University, Hongcheon, Korea, 37°44'25"N 127°49'54"E, 10 V 2002, alt. 220 m, H.D. Shin (KUS-F50507).

ETYMOLOGY – the specific epithet 'staphyleae' refers to the host plant.

APOTHECIA superficial, scattered to gregarious, seated on a very short stipe, appearing nearly sessile. **RECEPTACLE** at first almost globose, then becoming cupulate to shallow-cupulate, cream-colored to pale cinnamon when fresh, turning whitish to cream colored when dry, externally covered with whitish hairs. **DISC** up to 1 mm in diameter, pale cream-colored to pale buff when fresh and dry. **STIPE** very short, about 0.1 mm long, concolorous with the receptacle. **HAIRS** cylindric, apically tapering and pointed, hyaline, septate, thin-walled, fragile, firmly agglutinated to form triangular teeth at the margin of apothecium, externally smooth, 20–56 µm long, 2–3.5 µm wide. **ECTAL EXCIPULUM** of textura prismatica, cells hyaline, thin-walled, 9–11.5 × 4.5–8 µm. **ASCI** not

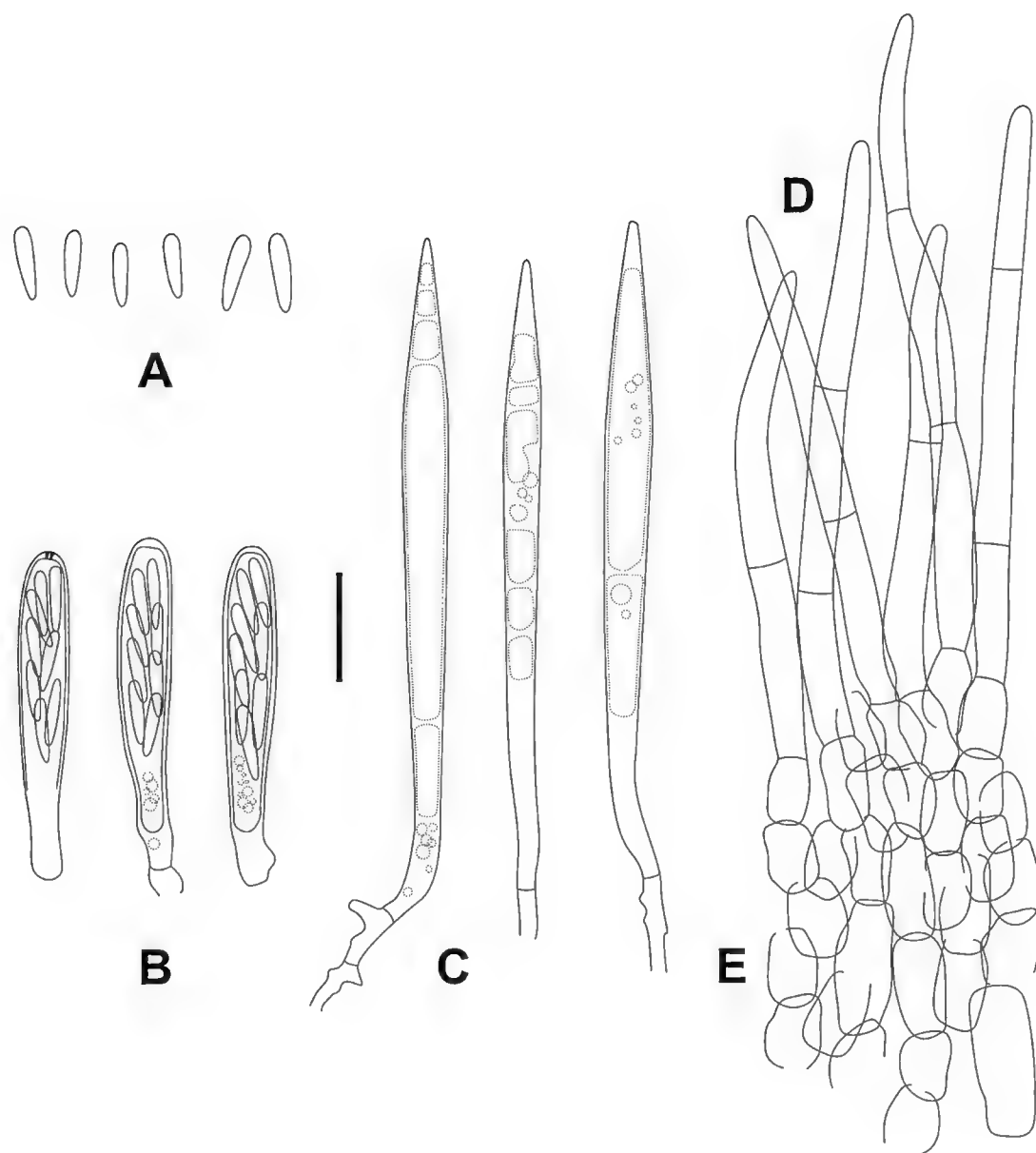


FIGURE 1. *Psilachnum staphyleae* (holotype KUS-F50507).
A: ascospores, B: asci, C: paraphyses, D: hairs, E: ectal excipulum.
Scale bar = 10 μ m.

arising from croziers, cylindric-clavate, 8-spored, $33\text{--}46 \times 4\text{--}5 \mu\text{m}$, apical pore blued in MLZ and IKI without KOH-pretreatment. ASCOSPORES biseriate to obliquely uniseriate, narrowly clavate-fusoid, sometimes narrowly cylindric-fusoid, straight to slightly curved, hyaline, aseptate, two small polar guttules visible in vital status, $(5.5\text{--})5.7\text{--}7.2(-8) \times (1\text{--})1.1\text{--}1.4(-1.6) \mu\text{m}$, avg. $6.4 \times 1.3 \mu\text{m}$ ($n = 40$). PARAPHYSES lanceolate, tapering to a sharp apex, exceeding the asci by $12\text{--}21 \mu\text{m}$, $2.5\text{--}4 \mu\text{m}$ wide, uni- to bi-septate near the base.

ADDITIONAL SPECIMENS EXAMINED – KOREA: YANGPYEONG, Experimental Forest of Korea University, $37^{\circ}24'49''\text{N}$ $127^{\circ}45'4''\text{E}$, alt. 110 m, 27 IV 2008, J.G. Han, M.J. Park and H.D. Shin (KUS-F52035); HONGCHEON, Bukbang-myeon, Bukbang-ri, $37^{\circ}42'45''\text{N}$ $127^{\circ}47'24''\text{E}$, alt. 260 m, 3 VI 2008, J.G. Han, M.J. Park and H.D. Shin (KUS-F52105, KACC44088).

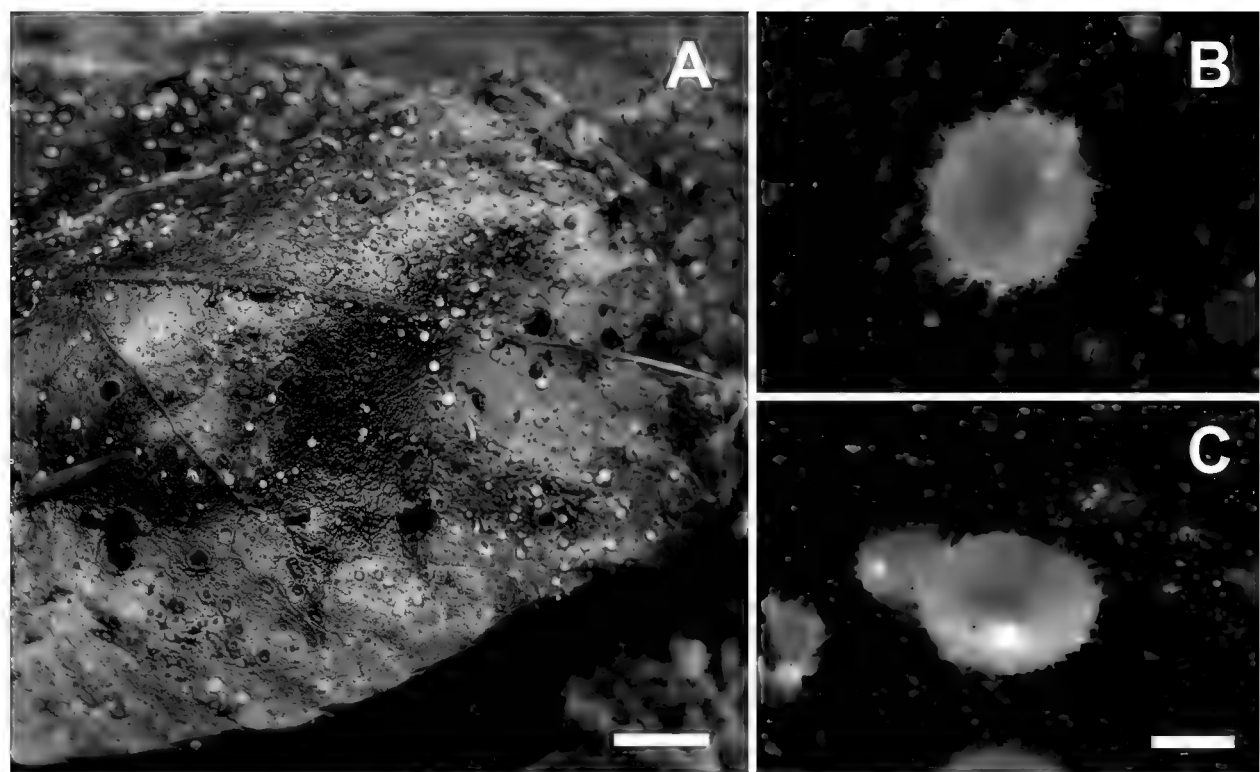


FIGURE 2. Flesh apothecia of *Psilachnum staphyleae* (KUS-F52105) on *Staphylea bumalda* leaves. Scale bars A = 10 mm, B–C = 2 mm.

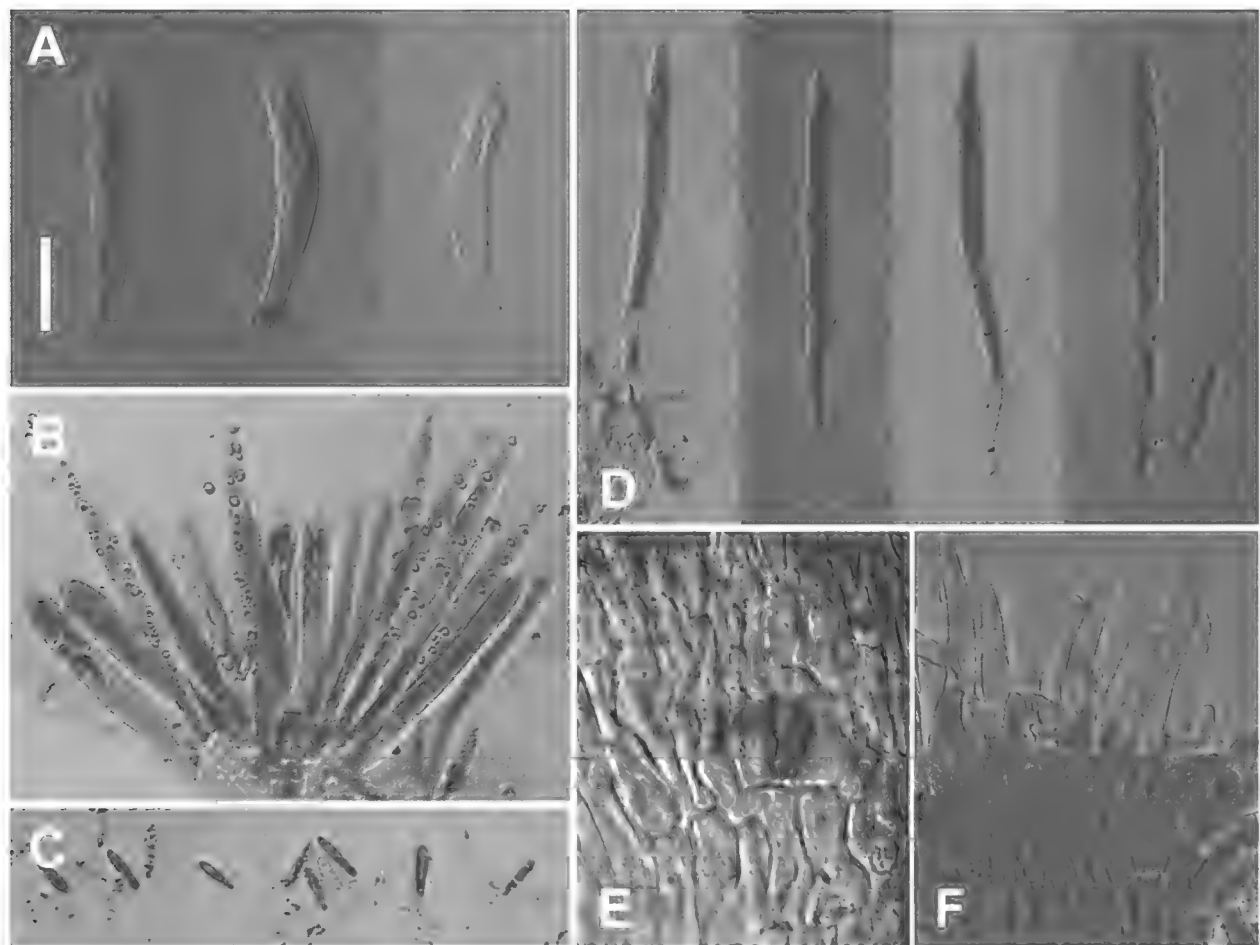


FIGURE 3. *Psilachnum staphyleae* (holotype KUS-F50507). A: asci arising from simple septa, apical pore blued in IKI, B: asci and paraphyses, note the paraphyses exceeding the asci, C: clavate ascospores containing two small guttules, D: lanceolate paraphyses, E: ectal excipulum composed of prismatic cells, F: smooth walled hairs. Scale bar = 10 µm.

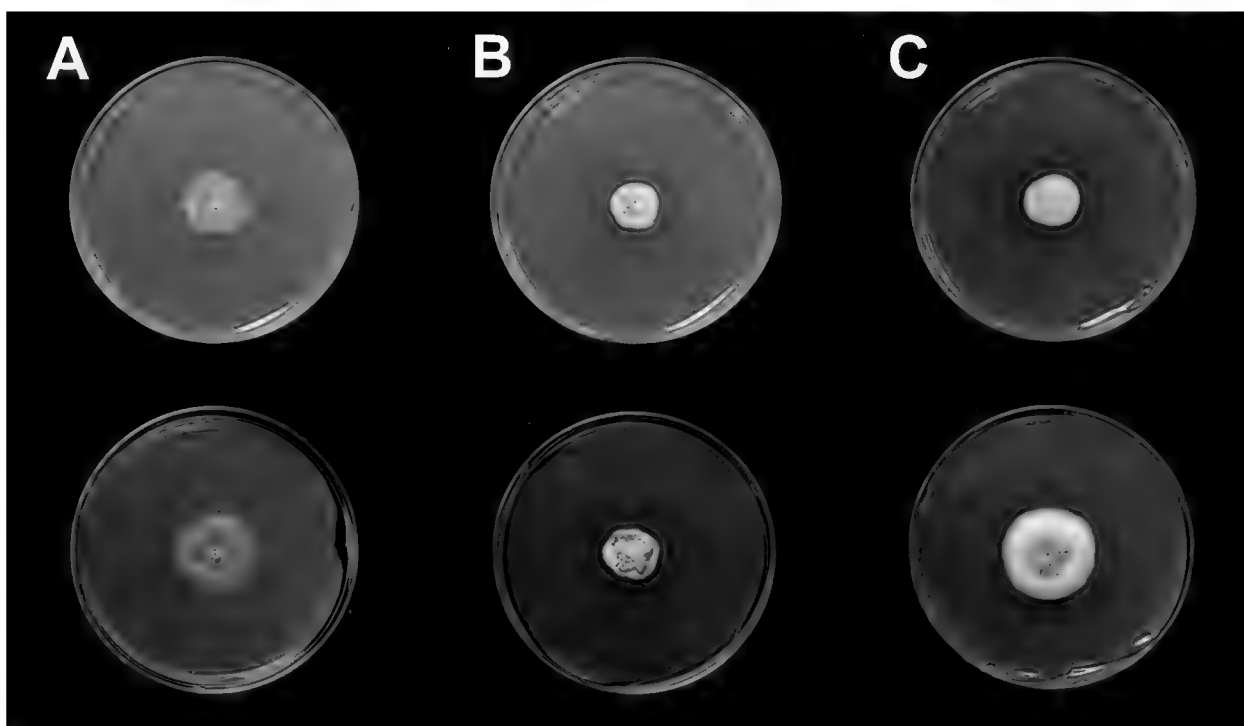


FIGURE 4. Colonies of *Psilachnum staphyleae* (KACC44088) incubated on CMA (A), MEA (B), and PDA (C) at room temperature after 5 weeks (upper line) and 10 weeks (lower line).

Colonies on CMA very slow growing; 18–22 mm in diameter after 5 weeks, 27–29 mm in diameter after 10 weeks; flat, slightly umbonate at the center; margins uneven; aerial hyphae sparsely diffused, felty, white; submerged mycelium glabrous, hyaline to ivory, faintly zonate with concentric bands; reverse concolorous; diffusing pigments absent; no sporulation observed (FIG. 4A).

Colonies on MEA very slow growing; 12–15 mm in diameter after 5 weeks, 17–20 mm in diameter after 10 weeks; slightly convex; margins uneven; aerial hyphae downy, grayish white; submerged mycelium light brown, cerebroid around the center; reverse light grayish brown, becoming dull mustard; pale brown pigment diffusing from the colony margin into the surrounding agar; no sporulation observed (FIG. 4B).

Colonies on PDA very slow growing; 15–17 mm in diameter after 5 weeks, 27–30 mm in diameter after 10 weeks; convex; margins entire; aerial hyphae felty, grayish white, partly yellowish brown; submerged mycelium not visible from above; in reverse brown to chestnut, darkening toward the center, margins ivory; pale brown pigment diffusing from the colony margin into the surrounding agar; no sporulation observed (FIG. 4C).

Results and discussion

Psilachnum is a widely distributed genus of *Hyaloscyphaceae* occurring on various kinds of substrates including monocotyledonous and dicotyledonous

herbaceous stems, fronds, or stems of pteridophytes and wood. The combination of ellipsoid or fusoid ascospores, cylindric to narrowly lanceolate paraphyses and small hairy apothecia is reminiscent of *Lachnum* Retz., but they are distinguished from this genus by their smooth-walled cylindric hairs.

Psilachnum staphyleae is typical of the genus, differing from the known species by the combination of its almost sessile apothecia, asci not arising from croziers, and foliicolous habit (FIGS 2–3). Although the fallen leaves of various deciduous trees and grasses were tightly mixed on the ground, the apothecia of this species were only found on *Staphylea bumalda*, which suggests that *P. staphyleae* is substrate-specific to leaves of this plant.

Psilachnum chrysostigmum (Fr.) Raitv. 1970 has ascospores of similar shape and size ($6.5\text{--}9 \times 1.5\text{--}2 \mu\text{m}$), but differs by its yellowish disc as well as smaller paraphyses which are $2.5\text{--}3 \mu\text{m}$ in width and exceed the asci by only $10 \mu\text{m}$ (Raitviir 2004). Another comparable species, *P. inquilinum* (P. Karst.) Dennis 1962 is distinguished by the narrower paraphyses, up to $2.5 \mu\text{m}$ wide (Huhtinen 1987). *P. cassandrae* (Kanouse) Shoemaker et al. 1980 is the only species previously described from a dicotyledonous leaf. However, it is distinguished from *P. staphyleae* by its 1–2 mm long stipe (Raitviir 2004).

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Literature cited

- Dennis RWG. 1978. British *Ascomycetes*. J. Cramer, Vaduz.
- Galan R, Raitviir A. 1999. *Psilachnum opuntiae* sp. nov. (*Hyaloscyphaceae*) growing on *Opuntia cladodes* from Mexico. *Mycotaxon* 72: 163–169.
- Höhnelt F von. 1926. Über die Gattung *Pezizella* Fuckel. *Mitt. Bot. Inst. Techn. Hochsch. Wien* 3(2): 54–80.
- Huhtinen S. 1987. New Svalbard fungi. 123–151, in GA Larsen et al. (eds.), *Arctic and Alpine Mycology II*. New York, Plenum Press.
- Raitviir A. 2004. Revised synopsis of the *Hyaloscyphaceae*. *Scripta Mycol.* 20: 1–133.
- Sharma MP. 1988. A new species of *Psilachnum* Höhn. from India. *Nova Hedwigia* 46(3–4): 369–372.
- Zhuang WY, Yu ZH, Zhang YH, Ye M. 2002. Some new species and new records of discomycetes in China. IX. *Mycotaxon* 81: 27–34.

Two new species of cyphelloid fungi (*Basidiomycota*) from China

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Abstract — Two new species with cyphelloid morphology were reported from China. *Henningsomyces subiculatus* is distinguished from other species of *Henningsomyces* by having a subiculum. *Cyphellopsis changbaiensis*, characterized by ferruginous clavate pilei, a secondary pileus developed from the interior of the primary one and radially arranged pilei hyphae, resembles *C. anomala* except for smaller basidiospores and lack of a subiculum. A diagnostic key to all known species in *Cyphellopsis* was provided.

Key words — basidiomycete, taxonomy, wood-inhabiting fungi

Introduction

Cyphelloid fungi refer to species that produce cup-, bowl- or tube-shaped basidiocarps. They belong to the homobasidiomycetes and have been grouped in the artificial family “*Cyphellaceae*”, which probably is polyphyletic (Agerer 1986, Bodensteiner et al., 2004, Donk 1951, 1959, 1962, 1971, Singer 1986). The well known genera of cyphelloid fungi include *Amyloflagellula* Singer, *Calathella* D.A. Reid, *Calyprella* Quél., *Cyphellopsis* Donk, *Flagelloscypha* Donk, *Halocyphina* Kohlm. & E. Kohlm., *Henningsomyces* Kuntze, *Lachnella* Fr., *Merismodes* Earle, *Pellidiscus* Donk, *Phaeocyphellopsis* W.B. Cooke, *Phaeosolenia* Speg., *Plicaturopsis* D.A. Reid, *Rectipilus* Agerer, *Stigmatolemma* Kalchbr., *Stromatocyphella* W.B. Cooke, and *Woldmaria* W.B. Cooke.

Extensive investigation on Chinese wood-inhabiting fungi has been carried out and many new species have been described (Cui et al. 2008, Dai & Cui 2005, 2006, Dai et al. 2003, 2004, 2007, 2008, Dai & Penttilä 2006, Dai & Wu 2004, Dai & Yang 2008, Li et al. 2007, 2008, Yuan & Dai 2005, 2008). However, only few cyphelloid fungi have been reported.

During studies on the Chinese wood-inhabiting fungi, some fungi with cup- or tube-shaped hymenophores were collected, among which two undescribed species of *Henningsomyces* and *Cyphellopsis* were identified, described here as *Henningsomyces subiculatus* and *Cyphellopsis changbaiensis*.

Materials and methods

The microscopic routine used in the study followed Yuan (2009). In the text the following abbreviations are used: L = mean spore length (arithmetical average of all spores), W = mean spore width (arithmetical average of all spores), Q = quotient of the mean spore length and width (L/W ratio). Sections were studied at magnification up to $\times 1000$ with a Nikon E 80i microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube.

Taxonomy

Henningsomyces subiculatus Y.L. Wei & W.M. Qin, sp. nov.

FIG. 1

MYCOBANK MB 515095

Carpophorum annuum, facies pororum niveum. Tubulum, up to 300 μm in longitudum, gregariae; pori rotundi, 100 μm in diam; subiculum praesens. Systema hypharum monomiticum, hyphae generatoriae fibulatae vel sine fibulis, hyphae trama 2–4.8 μm in diam, hyphae subiculum 1.9–2.1 μm in diam. Basidiosporae subglobosae, hyalinae, $4.8\text{--}5.7 \times 4.3\text{--}5.1 \mu\text{m}$.

TYPE — China. Guangxi Autonomous Region, Longsheng County, Wenquan Forest Park, on fallen angiosperm trunk, 9.VIII.2005 Dai 6889 (HOLOTYPE in IFP).

ETYMOLOGY — *subiculatus* (Lat.): referring to the subiculum present in fruitbody.

FRUITBODY — Basidiocarps annual, soft when fresh, becoming a little chalky upon drying, white, no odour or taste when fresh, becoming pinkish buff after bruised and drying, occupying an area up to 6 cm long and 5 cm wide on substrate, small tubes densely aggregated. Tubes up to 300 μm long, the tube opening about 100 μm in diam., dissepiments thick, 30–40 μm . Subiculum present, brownish when dry, about 100 μm thick.

HYPHAL STRUCTURE — Hyphal system monomitic, hyphae bearing both clamp connections and simple septa, dextrinoid in Melzer's reagent and cyanophilous in Cotton Blue, hyphae broken in 5% KOH.

SUBICULUM — Hyphae hyaline, smooth, thick-walled with a wide lumen; bearing clamp connections, rarely branched, interwoven, 1.9–2.1 μm in diam.

TUBES — Hyphae hyaline, smooth, thin-walled; bearing both clamp connections and simple septa, rarely branched, winding, more or less parallel along the tubes, 2–4.8 μm in diam. Cystidia absent. Basidia broadly clavate, with four sterigmata and a basal clamp connection, dissolved in 5% KOH, $10\text{--}14 \times 7\text{--}9.5 \mu\text{m}$. Hyphae at tube-mouth (dissepimental edge) finely branched, dendrohyphidia alike.

SPORES — Basidiospores subglobose, hyaline, thin-walled, smooth, usually bearing a guttule, acyanophilous, inamyloid and non-dextrinoid, $(3.9\text{--})4.8\text{--}5.7(-6) \times (3.9\text{--})4.3\text{--}5.1(-5.5) \mu\text{m}$, L = 5.17 μm , W = 4.82 μm , Q = 1.07–1.08 (n = 56/2).

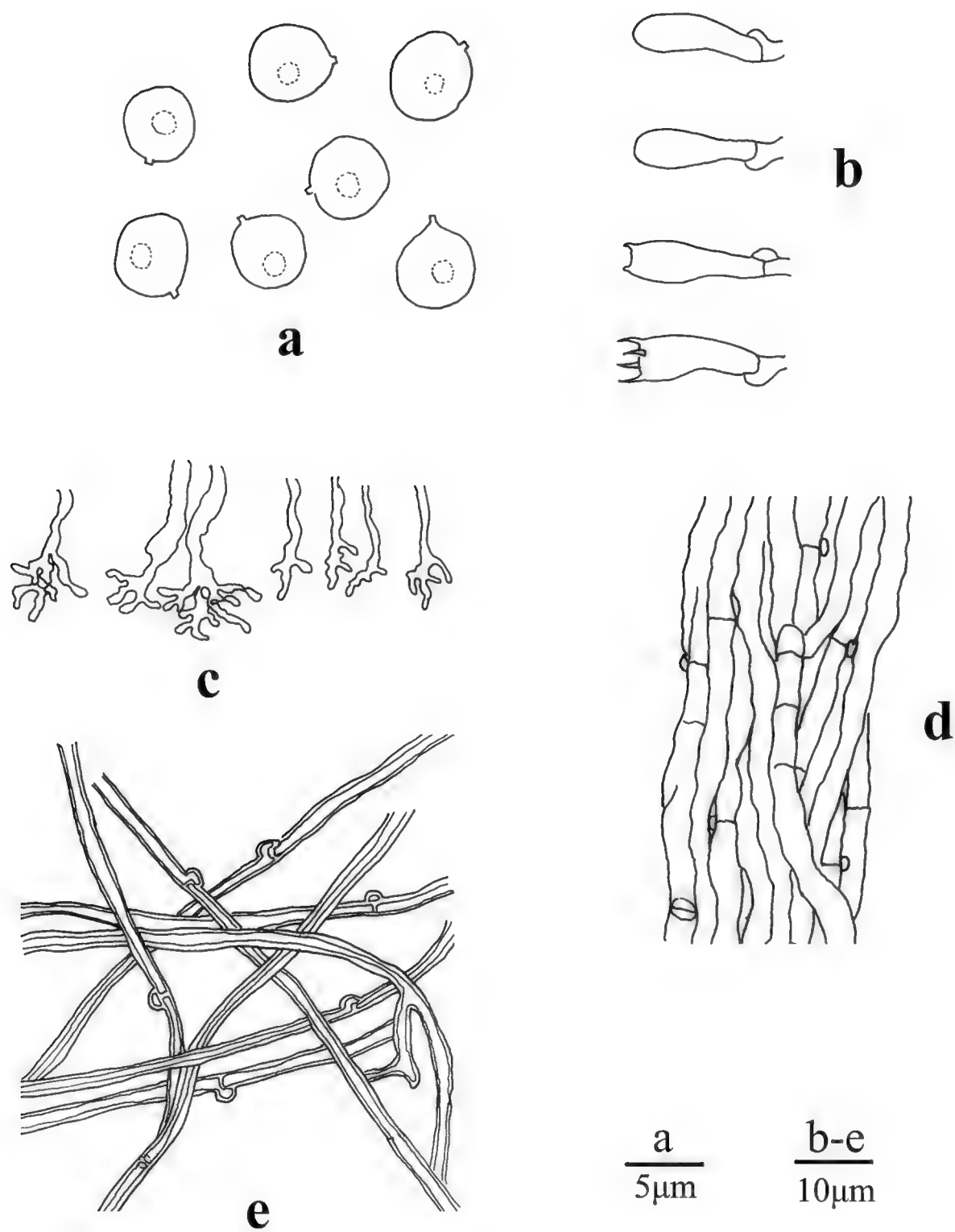


FIG. 1. Microscopic structures of *Henningsomyces subiculatus* (drawn from the holotype).
—a: Basidiospores. —b: Basidia and basidioles. —c: Hyphae from tube-mouth (dissepimental edge). —d: Hyphae from tube. —e: Hyphae from subiculum.

ADDITIONAL SPECIMEN (PARATYPE) EXAMINED — China. Hainan Province, Baoting County, Qixianling Forest Park, on rotten angiosperm wood, 28.V.2008 Dai 9756 (IFP).

COMMENTS — The presence of a subiculum separates *Henningsomyces subiculatus* from other species of the genus (Agerer 1973, Gilbertson et al. 2001).

Two species of *Henningsomyces*, *H. candidus* (Pers.) Kuntze and *H. leptus* Y.L. Wei & Y.C. Dai, have been previously reported from China (Wei & Dai 2007, Wei et al. 2007). They have spores similar to those in *H. subiculatus*. However besides having the subiculum, *H. subiculatus* differs from the other two Chinese species in tube length: the tubes of *H. subiculatus* are shorter (less than 0.3 mm), while they are 0.5–1 mm long in *H. candidus* (Breitenbach 1986) and up to 1.8 mm long in *H. leptus* (Wei & Dai 2007).

***Cyphellopsis changbaiensis* Y.L. Wei & W.M. Qin, sp. nov.**

FIG. 2

MYCOBANK MB 515096

Carpophorum annuum, facies pororum ferruginum; pori rotundi, 200–400 μm in diam. Subiculum nullum. Systema hypharum dimiticum, hyphae generatoriae fibulatae, 1.8–2 μm in diam, hyphae skeletales crassitunicatae, encrustata, 3–3.8 μm in diam. Basidiosporae ellipsoideae, hyalinae, crassitunicatae, 5.2–6.2 \times 3.5–4.2 μm .

TYPE — China. Jilin Prov., Antu County, Changbaishan Nature Reserve, on fallen trunk of *Quercus*, 15.VII.2007 Dai 8281 (HOLOTYPE in IFP).

ETYMOLOGY — *changbaiensis*: referring to the mountain of Changbai in Jilin Province, NE China.

FRUITBODY — Basidiocarps annual, ferruginous when fresh, effused, forming an area up to 10 cm across, coriaceous, becoming hard fragile upon drying, consisting of small crowded ferruginous pilei (tube-alike) which confluent, pyriform, unceolate, or long clavate, mouths 200–400 μm in diam., tube margin inrolled, outer surface with radial striae, velutinate. A second pileus developed from the interior of an older one, the whole length of pilei up to 1 mm. Subiculum absent.

HYPHAL STRUCTURE — Hyphal system dimitic; generative hyphae bearing clamp connections; all hyphae negative both in Melzer's reagent and Cotton Blue; tissues unchanged in KOH.

TUBES — Generative hyphae scanty, hyaline, thin-walled, smooth, occasionally branched, interwoven, 1.8–2 μm ; skeletal hyphae dominant, thick-walled with a narrow lumen to almost solid, red-brown, finely encrusted and hamate, unbranched, 3–3.8 μm in diam. Cystidia absent. Basidia clavate, with four sterigmata and a basal clamp connection, 17–24 \times 4.8–5.1 μm .

SPORES — Basidiospores ellipsoid, hyaline, thick-walled, smooth, slightly cyanophilous, inamyloid and non-dextrinoid, (5–)5.2–6.2(–6.3) \times (3–)3.5–4.2(–4.3) μm , $L = 5.73 \mu\text{m}$, $W = 3.95 \mu\text{m}$, $Q = 1.45$ ($n = 32/1$).

COMMENTS — The ferruginous basidiocarps of the new species resemble those of *Cyphellopsis anomala* (Pers.) Donk; both species also develop a secondary pileus from the interior of an older one. However, *C. anomala* differs from *C. changbaiensis* by having larger basidiospores (8–11 \times 5–6.5 μm) and a subiculum (Cunningham 1963).

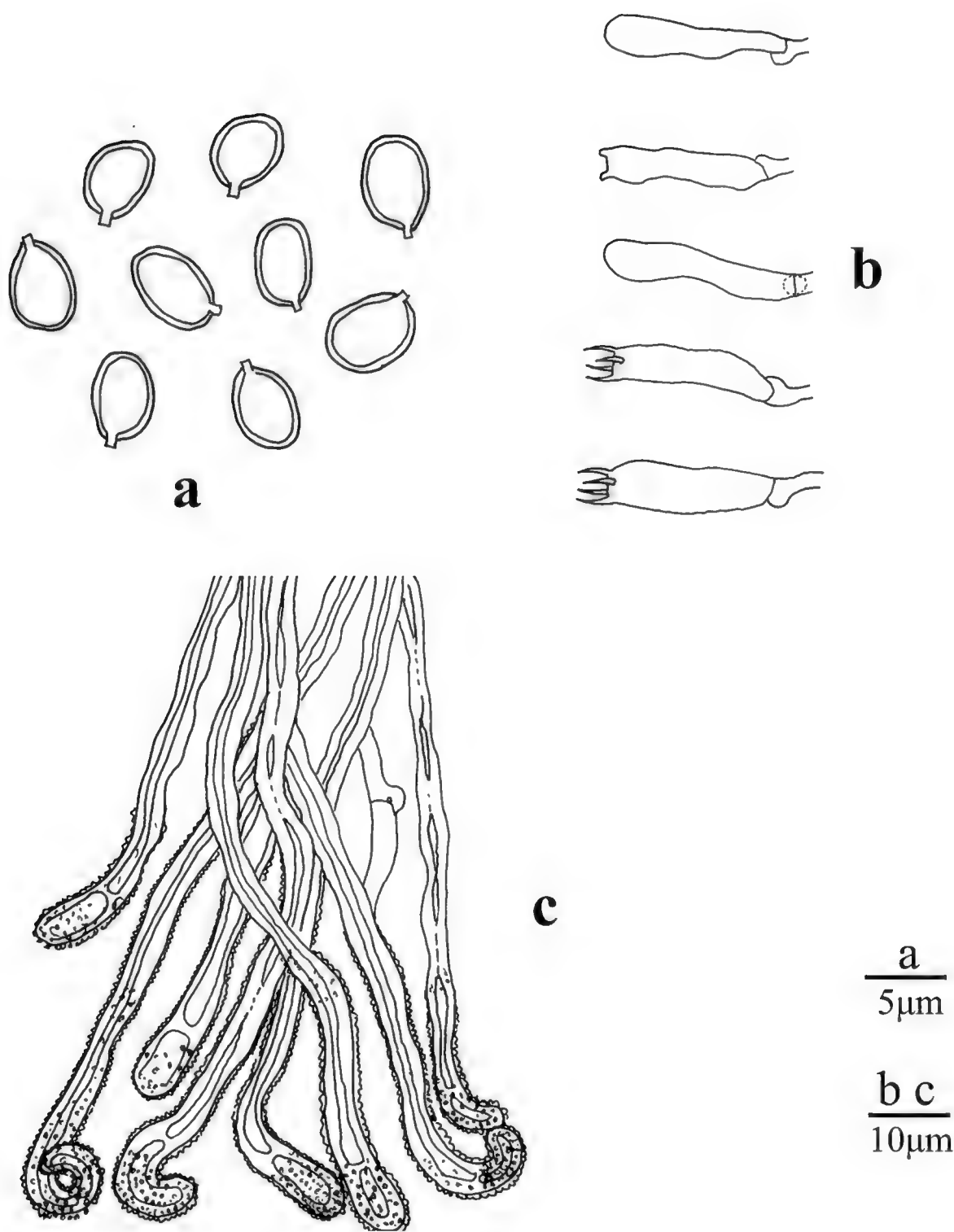


FIG. 2. Microscopic structures of *Cyphellopsis changbaiensis* (drawn from the holotype).
—a: Basidiospores. —b: Basidia and basidioles. —c: Hyphae from tube.

Donk based the genus *Cyphellopsis* on *C. anomala* (Donk 1931). In addition to *C. changbaiensis* and *C. anomala*, seven other *Cyphellopsis* species are currently recognized: *C. alboviolascens* (Alb. & Schwein.) Donk, *C. confusa* D.A. Reid, *C. maxima* (Masse) Donk, *C. mellea* (Burt) D.A. Reid, *C. monacha* (Speg.) D.A. Reid, *C. subglobispora* D.A. Reid, and *C. volkensii* (Henn.) Singer (Donk 1931; Reid 1961, 1963, 1964; Singer 1973). A key to these species is provided

below. [NOTE: The features for *C. volkensis* (basionym = *Cyphella variolosa* var. *volkensis* Kalchbr. & Henn.) are based primarily the description of *Cyphella variolosa* Kalchbr. by Cooke (1962).]

Key to *Cyphellopsis* species

- 1. Pilei large, ~12 mm in diam. *C. maxima*
- 1. Pilei smaller, ≤ 10 mm in diam. 2
- 2. Basidiospores colored 3
- 2. Basidiospores hyaline 4
- 3. Basidiospores at first hyaline, becoming brown (6-8 × 3-3.5 μm) *C. mellea*
- 3. Basidiospores brown from the first *C. volkensis*
- 4. Basidiospore wall thick 5
- 4. Basidiospore wall relatively thin 7
- 5. Pileus disciform or pezizaeform, spore length > 11 μm (12-17 × 9-11μm)
..... *C. alboviolascens*
- 5. Pileus pyriform, spore length < 11 μm.6
- 6. Basidiospores oblong-ellipsoid, bigger, (8-11 × 5-6.5 μm)*C. anomala*
- 6. Basidiospores ellipsoid, smaller (5.2–6.2 × 3.5–4.2 μm) *C. changbaiensis*
- 7. Basidiospore length > 9 μm (10-13.75 × 5.75-7.2 μm) *C. monacha*
- 7. Basidiospore length < 9 μm8
- 8. Pileus cushion-shaped, 1.5-3.5 mm in diam.;
basidiospores 7-8.2 × 2-2.2 μm *C. confusa*
- 8. Pileus subglobular or turbinate, 0.15-0.2 mm high, 0.13-0.15 mm wide;
basidiospores 7-8.75 × 5-6.5 μm *C. subglobispora*

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Literature cited

Agerer R. 1973. *Rectipilus*. Eine neue Gattung cyphelloider Pilze. Persoonia 7: 389–436.

Agerer R. 1986. “*Cyphellaceae*” versus *Tricholomataceae*, or what is a family. In: Borghi, E. (Ed.), La famiglia delle *Tricholomataceae*. Publ. Centro Studi per la Flora Mediterranea, Borgo Val di Taro.

Bodensteiner P, Binder M, Moncalvo JM, Agerer R, Hibbett DS. 2004. Phylogenetic relationships of cyphelloid homobasidiomycetes. Molecular Phylogenetics and Evolution 33: 501-515.

Breitenbach J, Kränzlin F. 1986. Fungi of Switzerland 2. Edition Mykologia Lucerne, Lucerne.

Cooke WB. 1962. The cyphelloaceous fungi. A study in the *Porotheleaceae*. Sydowia, Annales Mycologici, Beiheft 4: 1–144.

- Cui BK, Wang Z, Dai YC. 2008. *Albatrellus piceiphilus* sp. nov. on the basis of morphological and molecular characters. *Fungal Diversity* 28: 41–48.
- Cunningham GH. 1963. The *Thelephoraceae* of Australia and New Zealand. New Zealand DSIR Bulletin 145: 1–358.
- Dai YC, Cui BK. 2005. Two new species of *Hymenochaetaceae* from eastern China. *Mycotaxon* 94: 341–347.
- Dai YC, Cui BK. 2006. Two new species of *Wrightoporia* (*Basidiomycota*, *Aphyllaphorales*) from southern China. *Mycotaxon* 96: 199–206.
- Dai YC, Cui BK, Tao WQ. 2008. *Phellinus mori* sp. nov. (*Basidiomycota*, *Hymenochaetales*) from northern China. *Mycotaxon* 105: 53–58.
- Dai YC, Cui BK, Yuan HS. 2007. Notes on polypores from Gansu and Qinghai Province, northwest China. *Cryptogamie Mycologie* 28: 177–187.
- Dai YC, Härkönen M, Niemelä T. 2003. Wood-inhabiting fungi in southern China 1. Polypores from Hunan Province. *Ann. Bot. Fennici* 40: 381–393.
- Dai YC, Penttilä R. 2006. Polypore diversity of Fenglin Nature Reserve, northeastern China. *Ann. Bot. Fennici* 43: 81–96.
- Dai YC, Wei YL, Wang Z. 2004. Wood-inhabiting fungi in southern China 2. Polypores from Sichuan Province. *Ann. Bot. Fennici* 41: 319–329.
- Dai YC, Wu SH. 2004. *Megasporoporia* (*Aphyllaphorales*, *Basidiomycota*) in China. *Mycotaxon* 89: 379–388.
- Dai YC, Yang F. 2008. A new species of *Phellinus* (*Basidiomycota*, *Hymenochaetales*) from western China. *Mycotaxon* 104: 103–106.
- Donk MA. 1931. Revisie van de Nederlandse *Heterobasidiomycetae* (uitgezonderd *Uredinales* en *Ustilaginales*) en *Homobasidiomycetae*—*Aphyllaphoraceae*. Deel I. Meded. Ned. Mycol. Ver. 18–20: 65–200.
- Donk MA. 1951. The generic names proposed for *Hymenomycetes* 1. “*Cyphellaceae*”. *Reinwardtia* 1: 199–220.
- Donk MA. 1959. Notes on “*Cyphellaceae*” 1. *Persoonia* 1: 25–110.
- Donk MA. 1962. Notes on “*Cyphellaceae*” 2. *Persoonia* 2: 331–348.
- Donk MA. 1971. Progress in the study of the classification of the higher *Basidiomycetes*. In: Petersen, R.H. (Ed.), *Evolution in the higher Basidiomycetes*. University of Tennessee Press, Knoxville, USA, pp. 3–25.
- Gilbertson RL, Desjardin DE, Rogers JD, Hemmes DE. 2001. Fungi from the mamane-naio vegetation zone of Hawaii. *Fungal Diversity* 6: 35–69.
- Li J, Xiong HX, Dai YC. 2008. Polypores from Shennongjia Nature Reserve in Hubei Province, central China. *Cryptogamie Mycologie* 29: 267–277.
- Li J, Xiong HX, Zhou XS, Dai YC. 2007. Polypores (*Basidiomycetes*) from Henan Province in central China. *Sydowia* 59: 125–137.
- Reid DA. 1961. Fungi venezuelani: V. The *Cyphellaceae* of Venezuela. *Kew Bull.* 15: 261–275.
- Reid DA. 1963. New or interesting records of Australasian *Basidiomycetes*: V. *Kew Bulletin* 17: 267–308.
- Reid DA. 1964. Notes on some fungi of Michigan – I. ‘*Cyphellaceae*’. *Persoonia* 3: 97–154.
- Singer R. 1973. Diagnoses fungorum novorum agaricalium III. Beihefte zur *Sydowia* 7. 106 p.
- Singer R. 1986. The *Agaricales* in modern taxonomy, fourth ed. Koeltz Scientific Books, Königstein.
- Wei YL, Dai YC. 2007. Changbai wood-rotting fungi 15. *Henningsomyces leptus* sp. nov. *Mycotaxon* 101: 261–264.

- Wei YL, Yuan HS, Dai YC. 2007. First report of *Henningsomyces* (*Basidiomycetes*) in China. J. Fung. Res. 5: 187–189.
- Yuan HS, Dai YC. 2005. Two new species of *Steccherinum* (*Basidiomycota*) from China. Mycotaxon 93: 173–178.
- Yuan HS, Dai YC. 2008. Polypores from northern and central Yunnan Province, Southwestern China. Sydowia 60: 147–159.
- Yuan HS, Dai YC. 2009. Hydneous fungi of China 2: *Mycorrhaphium sessileum* sp. nov. Nova Hedwigia 88: 205–209.

**Hydnaceous fungi of China 4.
Mycoleptodonoides tropicalis sp. nov.,
and a key to the species in China**

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Abstract — *Mycoleptodonoides tropicalis* is illustrated and described as a new species from tropical forest in Yunnan Province, southwestern China. It is morphologically characterized by fan-shaped basidiocarps, hydroid hymenophore, fusiform cystidia, and smooth, subglobose to globose, non-amyloid basidiospores. A key to the Chinese species of *Mycoleptodonoides* is given.

Key words — *Basidiomycota*, lignicolous fungi, taxonomy

Introduction

Recently, significant progress has been made in the investigation of lignicolous fungi diversity in China (Cui & Dai 2006, Cui et al. 2007, 2008, 2009, Dai et al. 2003, 2004, 2007a,b, Dai & Yuan 2007). A number of species, mostly polyporoid (Dai 2004, Dai & Niemelä 2002, Dai & Penttilä 2006) and hydroid fungi (Yuan & Dai 2005, 2009), have been recorded or described. As a contribution to the study of hydnaceous fungi in China, an undescribed hydnaceous species of *Mycoleptodonoides* is described and illustrated in this paper. The knowledge of *Mycoleptodonoides* is summarized, and a key to Chinese species of the genus is provided.

The genus *Mycoleptodonoides* Nikol. is characterized by its pileate basidiocarps, hydroid hymenophore, a monomitic hyphal system, generative hyphae with clamp connections in both context and spine trama, basidia with a basal clamp connection, presence or absence of cystidia, and small, smooth, non-amyloid basidiospores (Maas Geesteranus 1971).

The genus was considered to be closely related to *Climacodon* P. Karst. and *Mycorrhaphium* Maas Geest. (Maas Geesteranus 1971). These three genera

share the hydroid hymenophore, a monomitic hyphal system in context, and small, smooth, non-amyloid basidiospores. However, *Climacodon* is now placed in family *Phanerochaetaceae* (Kirk et al. 2008), separated from the other two genera in family *Meruliaceae* (Kirk et al. 2008) by thick-walled or encrusted cystidia in the hymenium, generative hyphae with simple septa in the spine trama, and basidia with a basal simple septum. *Mycorrhaphium* is similar to *Mycoleptodonoides* in having clamp connections either in context or in spine trama, but the dimitic hyphal system in the spine trama readily distinguishes *Mycorrhaphium* from the latter (Yuan & Dai 2009).

Materials and methods

The studied specimens are deposited at Herbarium of Institute of Applied Ecology, Chinese Academy of Sciences (IFP) (<http://sweetgum.nybg.org/ih/>). The microscopic studies were made from sections mounted in Cotton Blue (abbreviated CB): 0.1 mg aniline blue dissolved in 60 g pure lactic acid; CB+ = cyanophily, CB- = acyanophily. Amyloid and dextrinoid reactions were tested in Melzer's reagent (IKI): 1.5 g KI (potassium iodide), 0.5 g I (crystalline iodine), 22 g chloral hydrate, aq. dest. 20 ml; IKI- = neither amyloid nor dextrinoid reaction. 5% KOH was used in the tests. Sections were studied at magnifications up to $\times 1000$ using a Nikon Eclipse E600 microscope and phase contrast illumination, and dimensions were estimated subjectively with an accuracy of $0.1\ \mu\text{m}$. In the spore measurements, the apiculus was excluded. In presenting the spore size variation, 5% of the measurements out of each end of the range are given in parentheses. The following abbreviations are used: L = mean spore length (arithmetical average of all spores), W = mean spore width (arithmetical average of all spores), Q = extreme values of the length/width ratios among the studied specimens, and n = the number of spores measured from a given number of specimens. Special colour terms follow Rayner (1970) and Petersen (1996).

Taxonomy

Mycoleptodonoides tropicalis H.S. Yuan & Y.C. Dai, sp. nov.

FIGS. 1, 2

MYCOBANK MB 513233

Carpophorum annuum, *pileatum*, *hydnameum*; *dentes usque ad 3.5 mm longi*, *3–4 per mm*. *Systema hypharum monomiticum*, *hyphae generatoriae fibulatae*, *hyphae contexti 3–7 μm in diam.* *Cystidia fusiformia*. *Sporae hyalinae, subglobosae vel globosae, non-amyloideae*, *2.9–3.3 \times 1.7–2 μm* .

TYPE. — **China**. Yunnan Prov., Menglun County, Xishuangbanna Botanical Garden, on angiosperm stump, 6.VIII.2005 Dai 6837 (**holotype** in IFP, **isotype** in H).

ETYMOLOGY — *tropicalis* (Lat.): referring to distribute in tropical forest.

FRUITBODY — Basidiocarps annual, pileate, sessile with a lateral base, solitary to imbricate, corky to soft fibrous, without odour and taste when fresh. Pilei fan-shaped to semicircular, projecting up to 6 cm, 5 cm wide and 0.5 cm thick. Upper surface velutinate to glabrous, scattered with small warts, indistinctly zonate, fawn to clay buff in central pileus, cream to pale buff at margin when



FIG. 1. Fruitbodies of *Mycoleptodonoides tropicalis*.

fresh, vinaceous buff when dry; margin acute, incurved when dry. Hymenophore hydroid, hymenophore between the spines velutinate; spines crowded, evenly distributed, buff when fresh, sienna to fulvous when dry, fibrous, subulate, terete or flattened, straight to somewhat flexuous, solitary or confluent, rare furcate, up to 3.5 mm long, 3–4 per mm; sterile margin smooth, up to 1 mm wide. Context buff, corky, azonate, homogeneous, up to 1.5 mm thick.

HYPHAL STRUCTURE — Hyphal system monomitic; generative hyphae bearing clamp connections, slightly thick to thick-walled, IKI–, CB–; tissues unchanged in KOH.

CONTEXT — Generative hyphae hyaline, slightly thick to thick-walled, moderately branched, 3–7 μm diam, loosely interwoven.

SPINES — Generative hyphae hyaline, thin to slightly thick-walled, moderately branched, 2–4 μm diam, parallel along the spine. Cystidia present, fusiform to ventricose, thin-walled, originating from subhymenium, 22–40 \times 6–7 μm . Basidia clavate, with a basal clamp connection and four sterigmata, 13–20 \times 4–5 μm ; basidioles in shape similar to basidia, but slightly smaller.

SPORES — Basidiospores subglobose to globose, hyaline, thin-walled, smooth, IKI–, CB–, (3.2–)3.3–4 (–4.1) \times 2.5–3 (–3.2) μm , $L = 3.66 \mu\text{m}$, $W = 2.84 \mu\text{m}$, $Q = 1.25–1.33$ ($n=60/2$).

ADDITIONAL SPECIMENS EXAMINED — *Mycoleptodonoides tropicalis*. China, Yunnan Prov., Menglun County, Xishuangbanna Botanical Garden, on angiosperm trunk, 29.IX.2008 *Yuan* 5472 (paratype, IFP). — *M. aitchisonii*. China, Heilongjiang Prov., Ning'an County, Jingbohu Forest Park, on fallen gymnosperm trunk, 10.IX.2007 *Dai*

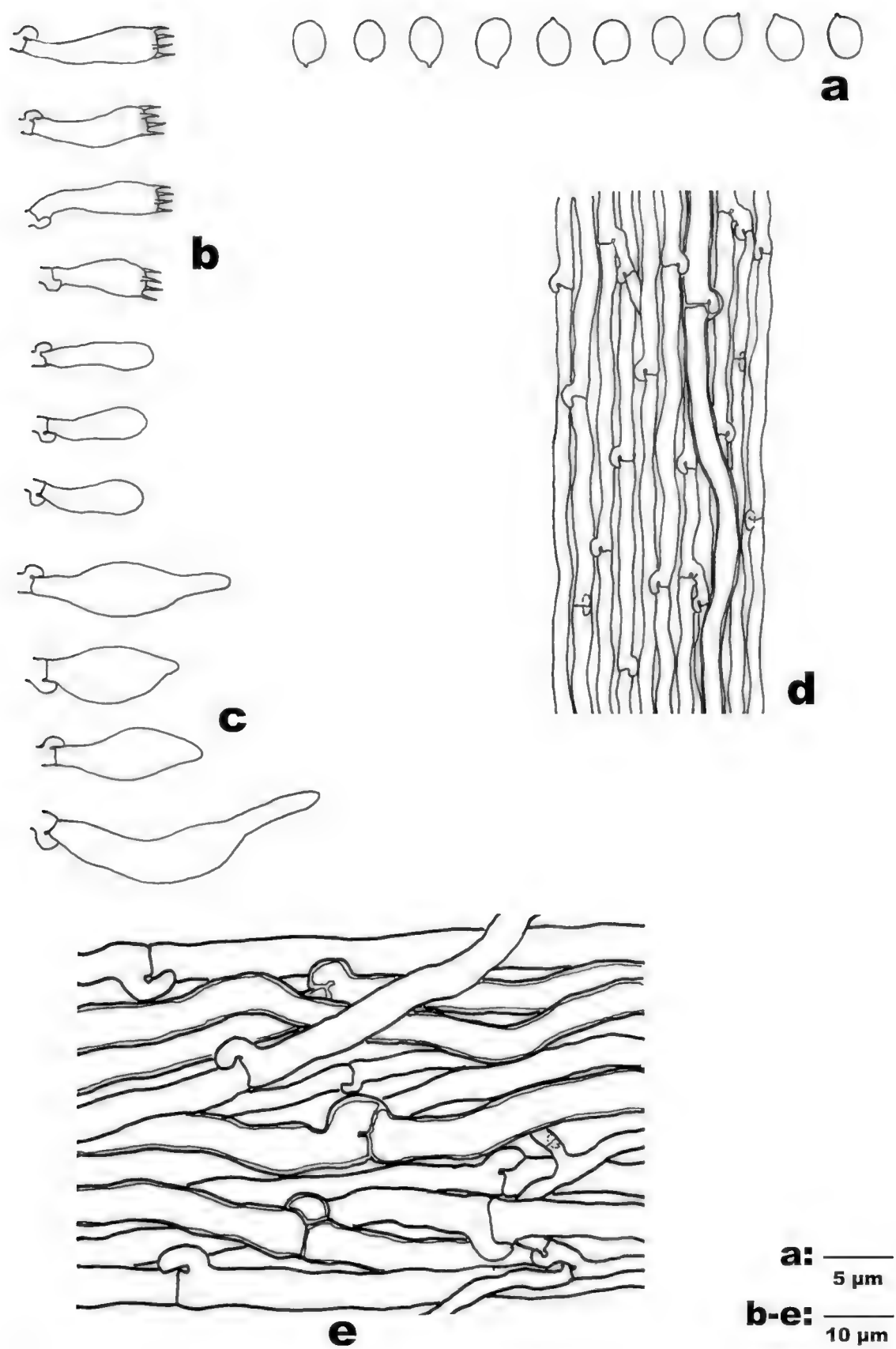


FIG. 2. Microscopic structures of *Mycoleptodonoides tropicalis* (drawn from the holotype).
—a: Basidiospores. —b: Basidia and basidioles. —c: Cystidia.
—d: Hyphae from spine trama. —e: Hyphae from context.

8922 (IFP); Hubei Prov., Fang County, Shennongjia Nat. Res., on angiosperm stump, 3.IX.2006 *Li* 1506 (IFP); Shaanxi Prov., Baoji County, Taibaishan Nat. Res., on fallen angiosperm branch, 17.IX.2005 *Wang* 504 (IFP). — *M. vassiljevae*. Russia, Primorie Reg., Suputinsky Nat. Res., on wood, 24.VIII.1946 *Vassiljeva* 22496 (LE); China, Jilin Prov., Antu County, Changbai Nat. Res., on dead angiosperm tree, 19.IX.2002 *Dai* 3815 (IFP); on fallen angiosperm trunk, 25.VIII.2007 *Wei* 3240 (IFP).

Discussion

Five species have been described in *Mycoleptodonoides*: *M. adusta* (Schwein.) Nikol., *M. aitchisonii* (Berk.) Maas Geest., *M. pergamenea* (Yasuda) Aoshima & H. Furuk., *M. pusilla* (Brot.) K.A. Harrison and *M. vassiljevae* Nikol. Among these species, *M. adusta* and *M. pusilla* have been transferred to genus *Mycorrhaphium* Maas Geest. for having dimitic hyphal system in spine trama (Maas Geesteranus 1962) and *M. pergamenea* is considered as a synonym of *M. aitchisonii* (Imazeki & Hongo 1989). Thus, *M. aitchisonii* and *M. vassiljevae* comprise the remaining accepted species in this genus. The former species has a wide distribution from subtropical to boreal areas. It is characterized by narrowly ellipsoid basidiospores ($5.4\text{--}6.3 \times 1.9\text{--}2.7 \mu\text{m}$), moderately inflated contextual hyphae (up to $15 \mu\text{m}$), and presence of thin-walled cystidia-like elements (Maas Geesteranus 1961, 1971). The latter species has been recorded from the type species locality (Ussuri, Russia) and Northeastern China (Dai et al. 2004, Nikolaeva 1952). The main characters of *M. vassiljevae* are the cylindric, slightly curved basidiospores ($4\text{--}5 \times 1.5\text{--}2 \mu\text{m}$), inflated contextual hyphae (up to $30 \mu\text{m}$), and absence of cystidia-like elements (Nikolaeva 1952).

Mycoleptodonoides tropicalis was found in tropical forest, and is readily distinguished from the other two species by subglobose to globose basidiospores ($3.2\text{--}4.1 \times 2.5\text{--}3.2 \mu\text{m}$), not inflated contextual hyphae (up to $7 \mu\text{m}$), and fusiform cystidia.

Key to species of *Mycoleptodonoides* from China

1. Basidiospores narrowly ellipsoid to cylindric, subtropical to boreal species 2
1. Basidiospores subglobose to globose, tropical species. *M. tropicalis*
2. Hyphae of the context up to $15 \mu\text{m}$, spores narrowly ellipsoid,
 $5.4\text{--}6.3 \times 1.9\text{--}2.7 \mu\text{m}$ *M. aitchisonii*
2. Hyphae of the context up to $30 \mu\text{m}$, spores cylindric, slightly curved,
 $4\text{--}5 \times 1.5\text{--}2 \mu\text{m}$ *M. vassiljevae*

Acknowledgements

We express our gratitude to Dr. Wjacheslav Spirin (Russia) and Dr. Tsutomu Hattori (Japan) for translation the Russian and Japanese literatures respectively. The research was supported by National Natural Science Foundation of China (Project No. 30700004 & 30670009).

Literature cited

- Cui BK, Dai YC, Decock C. 2007. A new species of *Perenniporia* (Basidiomycota, Aphyllophorales) from eastern China. *Mycotaxon* 99: 175–180.
- Cui BK, Dai YC, Li BD. 2009. Notes on the genus *Rigidoporus* (Basidiomycota, Polyporaceae) in China. *Nova Hedwigia* 88: 189–197.
- Cui BK, Huang MY, Dai YC. 2006. A new species of *Oxyporus* (Basidiomycota) from western China. *Mycotaxon* 96: 207–210.
- Cui BK, Wang Z, Dai YC. 2008. *Albatrellus piceiphilus* sp. nov. on the basis of morphological and molecular characters. *Fungal Diversity*: 28: 41–48.
- Dai YC. 2004. Notes on the genus *Antrodiella* (Basidiomycota, Aphyllophorales) in China. *Mycotaxon* 89: 389–398.
- Dai YC, Cui BK, Yuan HS. 2007a. Notes on polypores from Gansu and Qinghai Province, northwest China. *Cryptogamie Mycologie* 28: 177–187.
- Dai YC, Härkönen M, Niemelä T. 2003. Wood-inhabiting fungi in southern China 1. Polypores from Hunan Province. *Ann. Bot. Fennici* 40: 381–393.
- Dai YC, Niemelä T. 2002. Changbai wood-rotting fungi 13. *Antrodia* sensu lato. *Ann. Bot. Fennici* 39: 257–265.
- Dai YC, Penttilä R. 2006. Polypore diversity of Fenglin Nature Reserve, northeastern China. *Ann. Bot. Fennici* 43: 81–96.
- Dai YC, Wei YL, Yuan HS, Huang MY, Penzina T. 2007b. Polypores from Altay and Tian Mts. in Xinjiang, northwest China. *Cryptogamie Mycologie* 28: 269–279.
- Dai YC, Wei YL, Zhang XQ. 2004. An annotated checklist of non-poroid Aphyllophorales in China. *Ann. Bot. Fennici* 41: 233–247.
- Dai YC, Yuan HS. 2007. Type studies on polypores described by G.Y. Zheng and Z.S. Bi, from southern China. *Sydowia* 59: 25–31.
- Imazeki R, Hongo T. 1989. *Colored Illustrations of Mushrooms of Japan*, Vol. 2. Hoikusha, Osaka, p. 120.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. *Ainsworth & Bisby's dictionary of the fungi*, 10th edition. CAB International, Wallingford.
- Maas Geesteranus RA. 1961. A hydnum from Kashmir. *Persoonia* 1(4): 409–413.
- Maas Geesteranus RA. 1962. Hyphal structures in hydnums. *Persoonia* 2(3): 377–405.
- Maas Geesteranus RA. 1971. Hydneous fungi of the eastern old world. *Verhandelingen Der Koninklijke Nederlandse Akademie Van Wetenschappen*, Tweede Reeks 60 (3): 1–175, 8 plates.
- Nikolaeva TL. 1952. Novyi rod ezhovikovyykh (sem. *Hydnaceae*) gribov (A new genus of hydneous fungi). *Botanicheskie materialy otdela sporovyykh rastenii Botanicheskogo Instituta Akademii Nauk SSSR* 8: 117–121 (in Russian with Latin subheadings).
- Petersen JH. 1996. Farvekort. The Danish Mycological Society's colour-chart. - Foreningen til Svampekundskabens Fremme, Greve.
- Rayner RW. 1970. A mycological colour chart. Commonwealth Mycological Institute, Kew.
- Yuan HS, Dai YC. 2005. Two new species of *Steccherinum* (Basidiomycota) from China. *Mycotaxon* 93: 173–178.
- Yuan HS, Dai YC. 2009. Hydneous fungi of China 2: *Mycorrhaphium sessileum* sp. nov. *Nova Hedwigia* 88: 205–209.

***Septobasidium annulatum* sp. nov. (Septobasidiaceae) and *S. kameii* new to China**

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Abstract — A new species, *Septobasidium annulatum* on *Rhus potaninii* associated with nymphal stage of a scale insect, is described. It was collected from Shaanxi Province, China. A new Chinese record, *Septobasidium kameii* on *Castanea mollissima* associated with *Diaspidiotus* sp., is provided. It was collected from Anhui Province.

Key words — *Pucciniomycetes*, *Septobasidiales*, taxonomy

All specimens of *Septobasidium* deposited in our herbarium have been re-examined. Among them, a new species on *Rhus potaninii* was collected in Shaanxi Province, China. It was associated with the nymphal stage of a scale insect. We describe the new species as:

***Septobasidium annulatum* C.X. Lu & L. Guo, sp. nov.**

FIGS. 1, 3–8

MYCOBANK MB 514184

Basidiomata resupinata, annulata, 2.5–4.7 cm longa, 2.2–4 cm lata, griseo-brunnea vel brunnea, margine determinata, superficie laevia, in sectione 530–700(–970) µm crassa. Subiculum brunneum, 10–16 µm crassum. Columnae brunneae, 40–50 µm longae, 50–180 µm crassae, ex hyphis 2.5–3 µm latis compositae, interdum columnae nullae. Hymenium hyalinum, 105–320(–580) µm crassum, unistratosum vel 2-stratosum. Probasidia ovoidea vel subglobosa, 10–17 × 7–10.5 µm, hyalina, persistentia. Basidia cylindrica, curvata, 4-cellularia, 32–39 × 6–7 µm, hyalina. Haustoria ex hyphis irregulariter spiralibus constantia.

TYPE: On *Rhus potaninii* Maxim. (*Anacardiaceae*): China, Shaanxi, Hanzhong, 15.VII.1990, J.F. Chen, HMAS 59854 (**holotype**), associated with nymphal stage of a scale insect.

*corresponding author

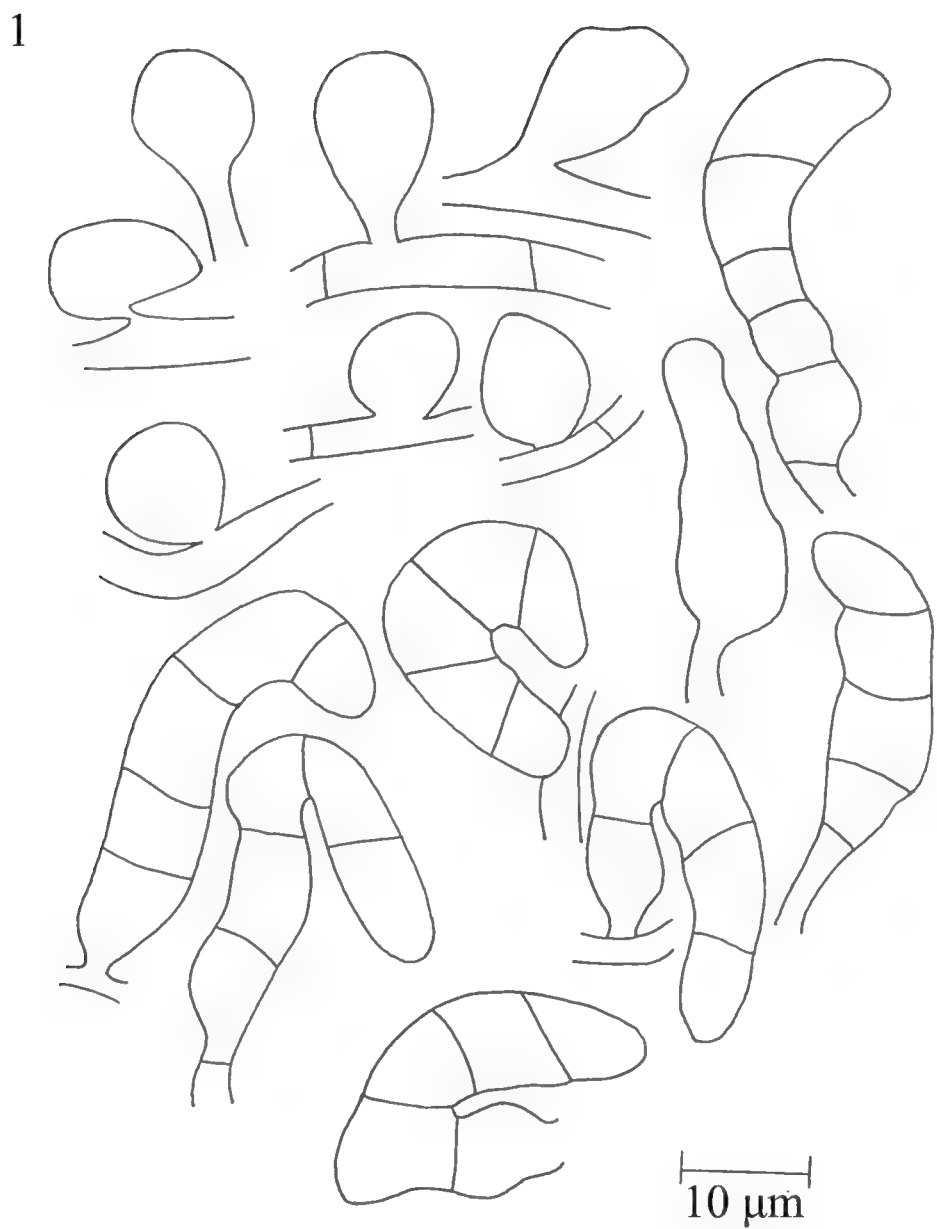


FIG. 1. Probasidia and basidia of *Septobasidium annulatum* (HMAS 59854, holotype).

Basidiomata on branches, resupinate, annulate, 2.5–4.7 cm long, 2.2–4 cm wide, pale greyish brown or brown; margin determinate; surface smooth. In section 530–700(–970) μm thick. Subiculum brown, 10–16 μm thick. Pillars brown, 40–50 μm long, 50–180 μm thick or loosely filled with hyphae; hyphae of pillars 2.5–3 μm thick, pillars branching out to form a layer (150–)390–520 μm thick. Hymenial layer hyaline, 105–320(–580) μm thick, single or 2-stratose. Probasidia ovoid or subglobose, 10–17 × 7–10.5 μm, hyaline; probasidial cell remaining after the formation of the basidia. Basidia cylindrical, curved, 4-celled, 32–39 × 6–7 μm, hyaline. Haustoria consisting of irregularly coiled hyphae. Basidiospores not seen.

REMARKS: The specimen was misidentified as *Septobasidium bogoriense* Pat. 1899. The new species differs from *S. bogoriense* in lacking distinct and tall

pillars and in sometimes having stratified hymenia. It lacks pillars in the young stage and has short, stubby pillars (40–50 μm high) in old stage. It produces annulate basidiomata with a thicker hymenium. This species is similar to *S. citricola* Sawada 1933 but differs in producing annulate, greyish-brown or brown basidiomata, shorter pillars and smaller basidia (32–39 \times 6–7 μm). The basidiomata of *S. citricola* are cream, the pillars are 84–126 μm high, and the basidia are 50–60 \times 8.2–9.7 μm .

The *Septobasidium* felt fungus is the main disease of chestnuts in Anhui province (Shu et al. 2007). In October 2008, several specimens of *Septobasidium* on *Castanea mollissima* were collected by the senior author and her colleagues. Unfortunately, no basidia were found in these specimens. In April and May of 2009, the same fungus was sent to the authors from Anhui Province. The fungus is identified as *S. kameii*, a new Chinese record:

2

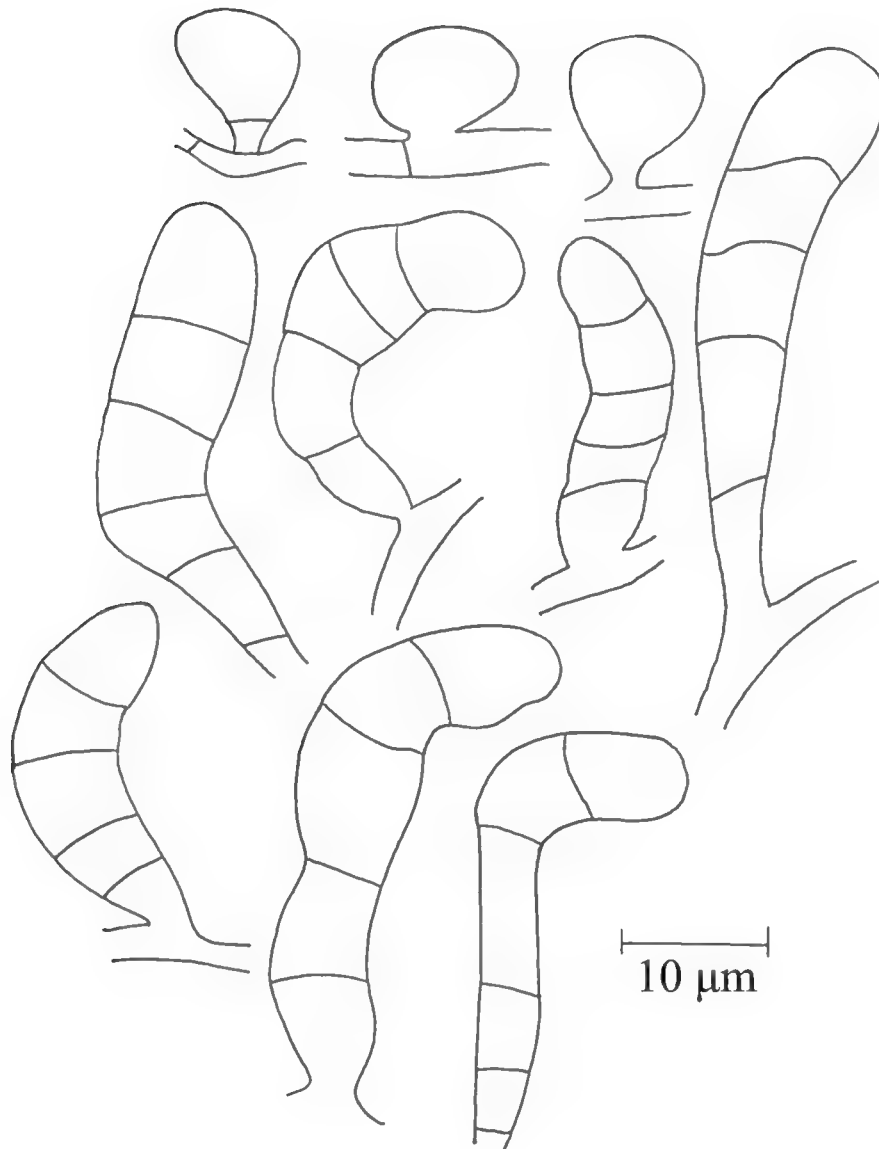
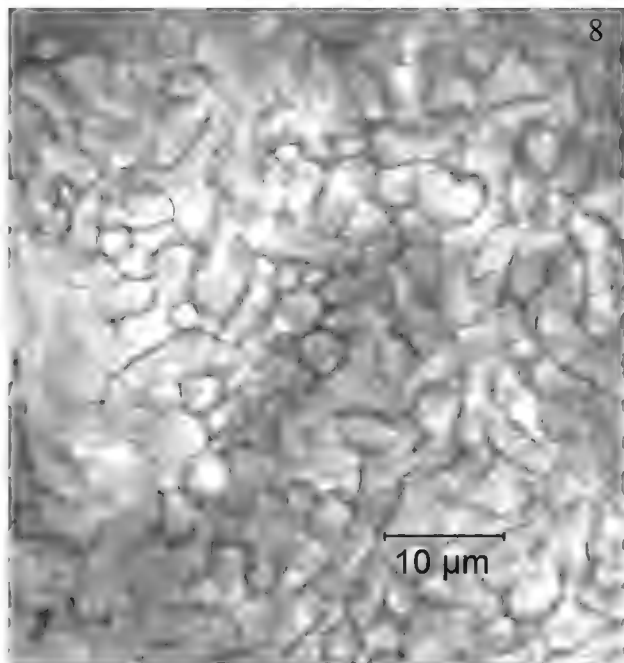
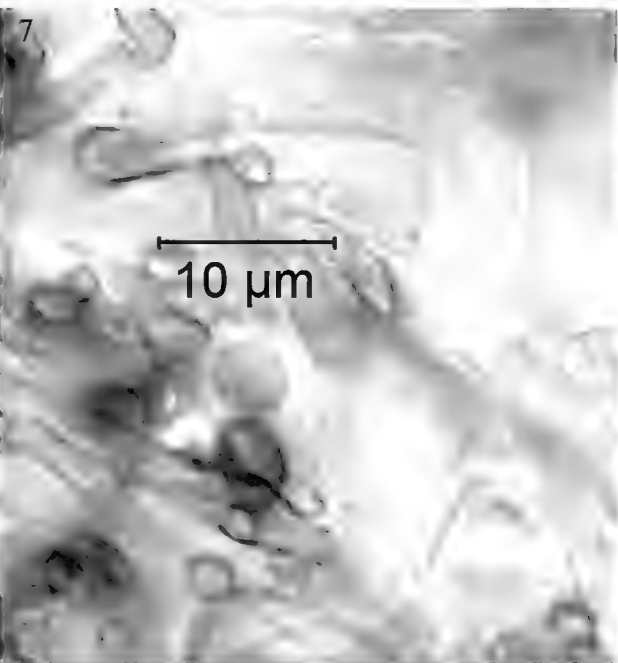
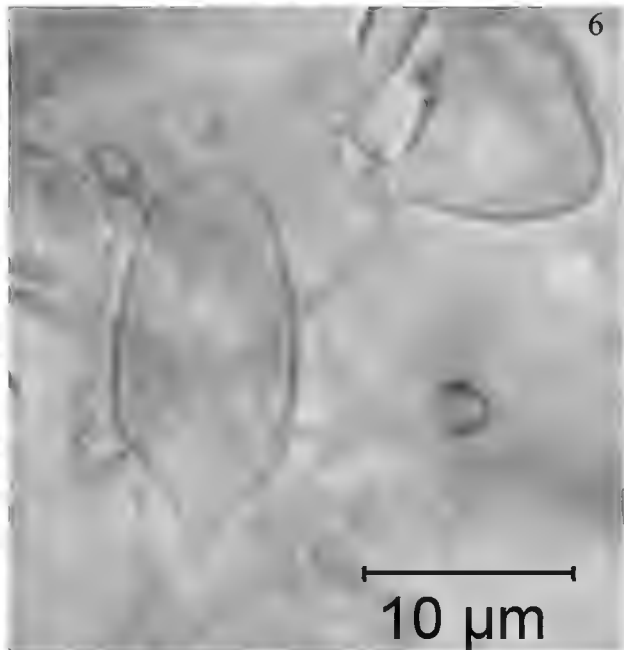
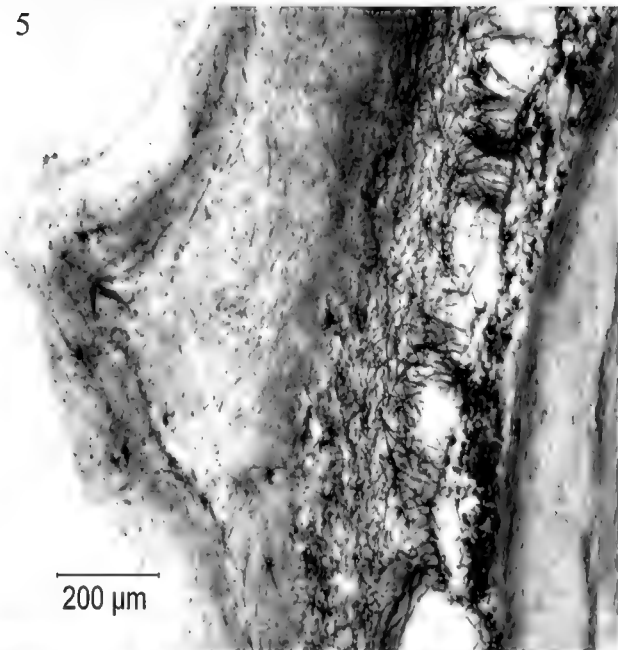
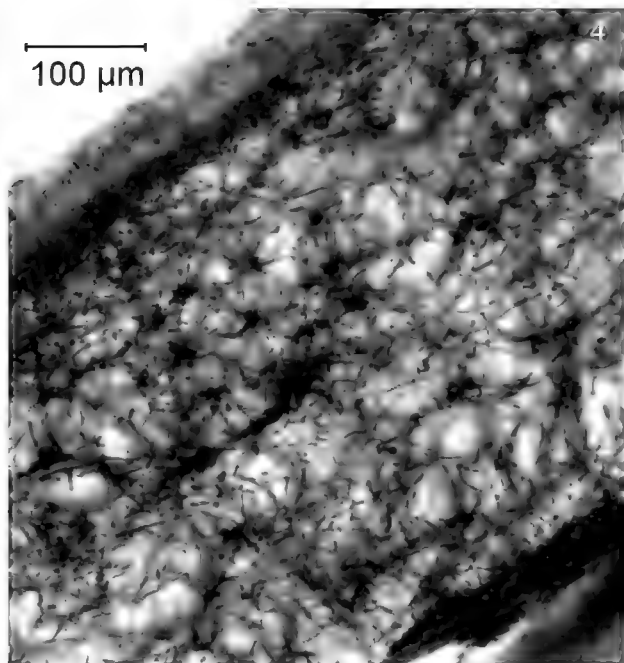


FIG. 2. Probasidia and basidia of *Septobasidium kameii* (HMAS 197040).



Septobasidium kameii Kaz. Itô, in Ito & Hayashi, Bull. Govt. For. Exp.

Sta. Meguro, Tokyo 134: 56, 1961.

FIGS. 2, 9–14

Basidiomata on trunks and branches, often girdling the limbs, resupinate, 5–19 cm long, 2–8 cm wide, sometimes forming long spines; spines 0.3–1 cm long, 0.5–1.5 mm wide, usually branched out at the top, smoke brown or cinnamon-brown; margin determinate; surface smooth in young stage, cracked by irregular fissures in old stage. In section 900–2000 µm thick. Subiculum 70–110 µm thick. Pillars 2–3-stratose, layers 500–740 µm high; hyphae of pillars 3–5 µm thick. Hymenial layer 70–120 µm thick, single or stratose. Probasidia pyriform or subglobose, 9–12 × 8–10 µm, hyaline; probasidial cell remaining after the formation of the basidia. Basidia cylindrical, 4-celled, curved, 22–36 × 5–10 µm, hyaline. Haustoria consisting of irregularly coiled hyphae. Basidiospores not seen.

SPECIMENS EXAMINED: On *Castanea mollissima* Blume (*Fagaceae*), associated with *Diaspidiotus* sp. (*Diaspididae*): China, Anhui, Shucheng, Ganhanhezhen, alt. 70 m, 15.X.2008, S.H. He, Y.F. Zhu & L. Guo 2482, HMAS 196463; Anhui, Shucheng, Hepengzhen, alt. 300 m, 27.IV.2009, W.Y. Zhan 1, HMAS 197040; Anhui, Shucheng, Hepengzhen, Zhanchong, 14.V.2009, D.Q. Liu 1, HMAS 197041; Anhui, Shucheng, Luzhen, Huangbaicun, 16.V.2009, D.Q. Liu 2, HMAS 196462.

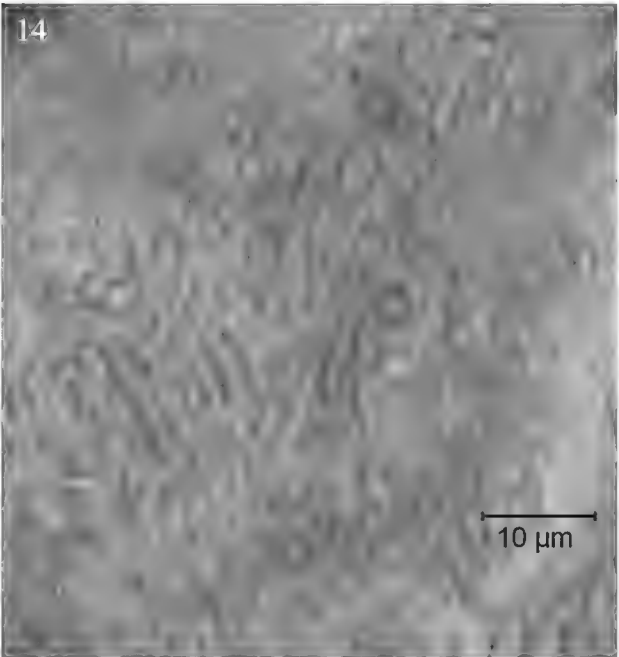
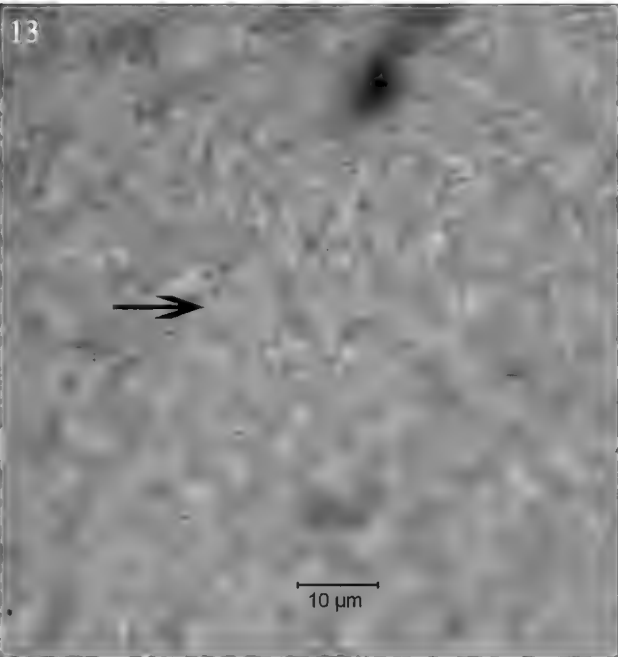
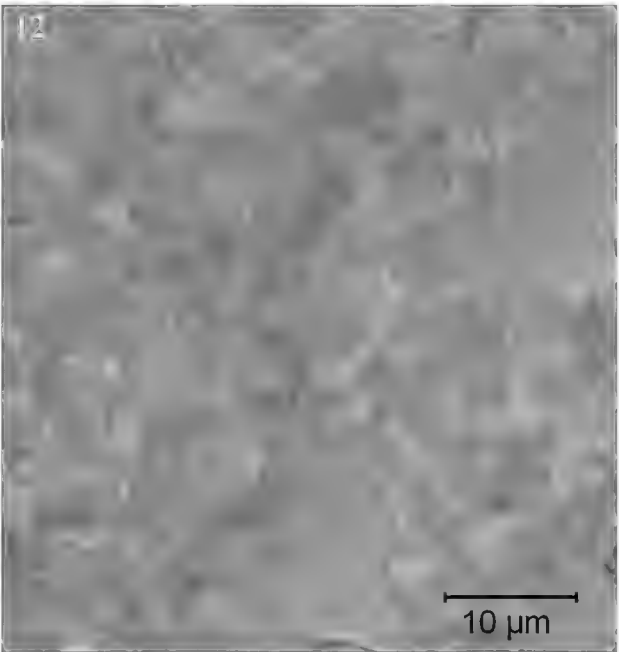
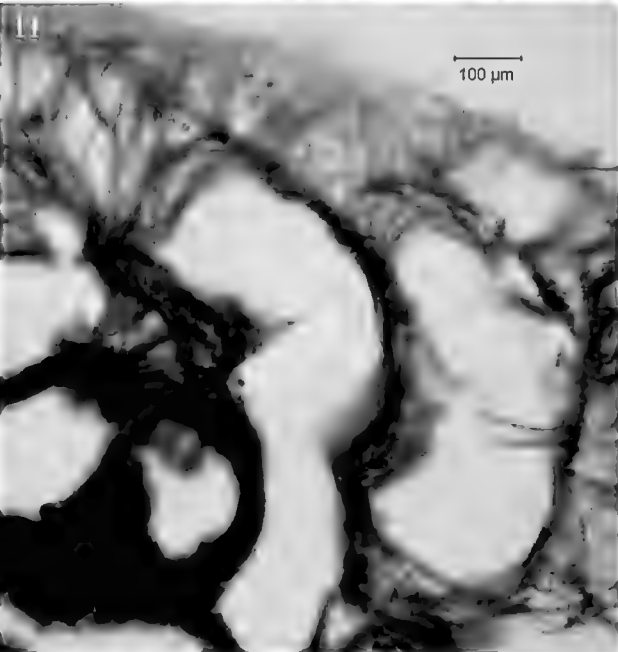
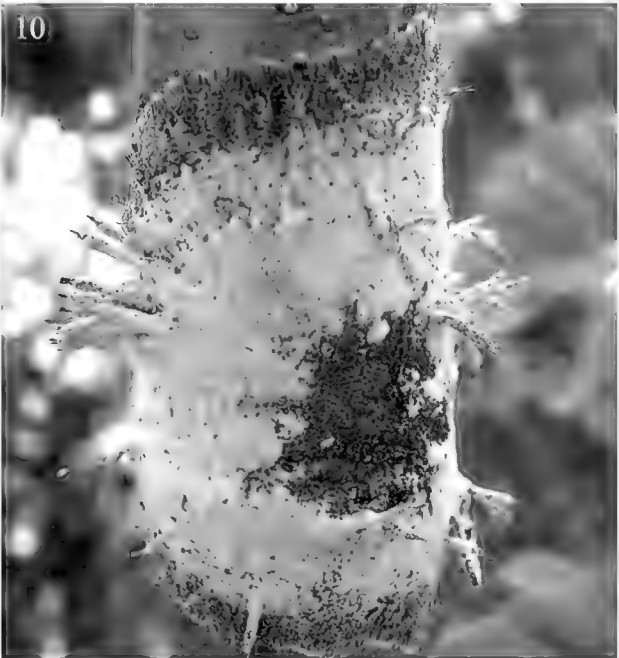
REMARKS: The specimen was associated with a scale insect, *Diaspidiotus* sp. (*Diaspididae*). The Chinese specimens form peculiar 2–3-stratose pillars, characteristic of *Septobasidium kameii* originally recorded in Japan (Ito & Hayashi 1961) but differ in having long spines (0.3–1 cm long).

To date, 19 *Septobasidium* species have been reported in China (Sawada 1931, 1933; Couch 1938; Teng 1963; Tai 1979; Kirschner & Chen 2007; Lu & Guo 2009a, b), including the two species reported in this paper.

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The authors would like to express their deep thanks to Drs Eric H.C. McKenzie (Auckland, New Zealand) and Wei Jiguang (Nanning, China) for serving as pre-submission reviewers, to Dr. Shaun Pennycook (Auckland, New Zealand) for nomenclatural review, to Prof. Zhuang Jianyun (Institute of Microbiology, Chinese Academy of Sciences) for Latin corrections, to Prof. Wu Sanan (Beijing Forestry University) for identifying the scale insects, and to Mrs. Zhu Xiangfei for inking in line drawings. This study was supported by the National Natural Science Foundation of China (No. 30499340).

FIGS. 3–8 (to left). *Septobasidium annulatum* (HMAS 59854, holotype). 3. Basidiomata on branches. 4–5. Sections of basidiomata. 6. Probasidia. 7. A basidium. 8. Haustoria.



Literature cited

- Couch JN. 1938. The Genus *Septobasidium*. Univ. of North Carolina Press, Chapel Hill. 480 p.
- Itô K, Hayashi H. 1961. A new species of *Septobasidium* on *Abies* and *Picea*. Bull. Gov. For. Exp. Sta. Tokyo 134: 49–64.
- Kirschner R, Chen CJ. 2007. New reports of two hypophyllous *Septobasidium* species from Taiwan. Fung. Sci. 22(1,2): 39–46.
- Lu CX, Guo L. 2009a. *Septobasidium maesae* sp. nov. (*Septobasidiaceae*) from China. Mycotaxon 109: 103–106.
- Lu CX, Guo L. 2009b. Two new species of *Septobasidium* (*Septobasidiaceae*) from China. Mycotaxon 109: 477–482.
- Sawada K. 1931. Descriptive catalogue of the Formosan fungi. Part V. Rep. Dept. Agric. Govt. Res. Inst. Formosa 51: 1–131.
- Sawada K. 1933. Descriptive catalogue of the Formosan fungi. Part VI. Rep. Dept. Agric. Govt. Res. Inst. Formosa 61: 1–99.
- Shu QL, Liu LY, Dong CY, Yang GD. 2007. Relationship between *Septobasidium* felts and varieties and interior substance of peel of *Castanea mollissima*. J. Anhui Agr. Univ. 34: 334–337.
- Tai FL. 1979. Sylloge Fungorum Sinicorum. Science Press, Beijing. 1527 p.
- Teng SC. 1963. Fungi of China. Science Press, Beijing. 808 p.

FIGS. 9–14 (to left). *Septobasidium kameii*. 9–10. Basidiomata on trunks (HMAS 196463). 11. Section of basidioma (HMAS 196463). 12. Probasidia (HMAS 197040). 13. Basidia (arrow) (HMAS 197040). 14. Haustoria (HMAS 196463).

***Xeromphalina junipericola*, a rare species new to southeastern Europe**

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Abstract — *Xeromphalina junipericola*, a species new to Turkish and Macedonian mycobiota, is described. This wood-decaying fungus has been collected on stumps of juniper trees (*Juniperus excelsa* and *J. foetidissima*) in six localities situated in the central and southern part of Turkey, and on stump of *Juniperus excelsa* in one locality in Macedonia. It is a very rare species previously known only from a few localities in Spain. These finds will provide a better picture of its distribution area.

Key words — *Mycenaceae*

Introduction

Xeromphalina junipericola is a rare species previously known from only a few localities in Spain. The species has a violaceous to purplish tinged pileus, lamellae, and stipe, fusoid, non-coralloid cheilo- and caulocystidia, and small spores. Moreno & Heykoop (1996) described this species from Guadalajara province in Spain as a saprobe on *Juniperus thurifera*. The same area has been visited a number of times and the species has been collected again on the same substrate (Heykoop & Moreno 2007, Moreno et al. 2002).

Specimens collected during a collaborative project between the Institute of Biology within the Faculty of Natural Science and Mathematics in Skopje, the Republic (FYR) of Macedonia, and the Biology Department within the Science and Art Faculty, Selçuk University, from Konya, Turkey, have extended the known range of *X. junipericola* to southeastern Europe. A description based on several new collections is provided below.

Materials and methods

The material has been examined with Melzer's reagent and 5% KOH. The identification has been verified by consulting Antonín & Noordeloos (2004).

All specimens are stored at the Mushroom Application and Research Centre (Selçuk University, Konya, Turkey) or MCF, the Macedonian Collection of Fungi (Institute of Biology, Ss Cyril and Methodius University, Skopje, Macedonia).

Taxonomy

Xeromphalina junipericola G. Moreno & Heykoop, Z. Mykol. 62: 38, 1996

FIGS 1–5.

PILEUS 0.2–0.6 cm broad, globose to cyathiform at maturity, brown-reddish with wine-brown tinges, covered with yellowish-orange flocci. GILLS decurrent, narrow, rarely anastomosed, with scarce lamellulae, grey to grey-violaceous, L = 26–30, l = 1–2. STIPE 5–14 × 0.5–1.5 mm, cylindrical, concolorous with pileus or paler, covered with a whitish powdery bloom, with floccose base formed by ochraceous-orange hyphae. TASTE mild. ODOR not distinctive.

SPORES (3.4–)4.0–5.0(–5.4) × (2.0–)2.5–3.0(–3.2) µm, ellipsoid to cylindrical-ellipsoid, smooth, thin-walled, hyaline, amyloid. BASIDIA 20–25 × 4.0–5.0 µm, 4-spored, clavate. CHEILOCYSTIDIA 27–39 × 6.5–10 µm, fusoid to broadly utriform, (sub) lageniform, sometimes slightly irregular, long and narrow, thin-walled. TRAMA hyphae cylindrical, thin- to slightly thick-walled, mostly incrusted, up to 13 µm wide, incrustation brown in KOH. PILEIPELLIS consisting of cylindrical, slightly thick-walled incrusted hyphae, up to 10 µm diam, pigment brown in KOH. CIRCUMCYSTIDIA numerous, 32–52 × 5.0–8.2 µm, cylindrical, clavate, fusoid, irregular to subcoralloid, slightly thick-walled, smooth, pale to dark brown in KOH. STIPITPELLIS of parallel, cylindrical, slightly thick-walled, incrusted hyphae, brownish yellow in H₂O, yellow-brown in KOH, up to 10 µm diam. CAULOCYSTIDIA 45–85 × 6.7–8.6 µm, cylindrical, clavate, (sub)fusoid, (sub)utriform, sometimes rostrate, slightly thick-walled, pale brown to yellow-brown in KOH. CLAMP CONNECTIONS present.

Discussion

Xeromphalina junipericola is characterised by violaceous to purplish tinges in the pileus, lamellae, and stipe, fusoid, non-coralloid cheilo- and caulocystidia, and small spores. Together with “*X. minutissima*” Esteve-Rav. (nom. prov.), it has the smallest spores among European *Xeromphalina* species.

The distribution of this species has been insufficiently known until now and is known only from three countries — Spain, Macedonia, and Turkey. Our research up to now indicates that this species follows the distribution of scale-leaf juniper trees in Europe, such as *Juniperus excelsa*, *J. foetidissima*, and

FIGS. 1–5. *Xeromphalina junipericola*. 1. Basidiocarps. 2. Spores. 3. Cheilocystidia. 4. Pileipellis. 5. Caulocystidia and hyphae with clamp connections.

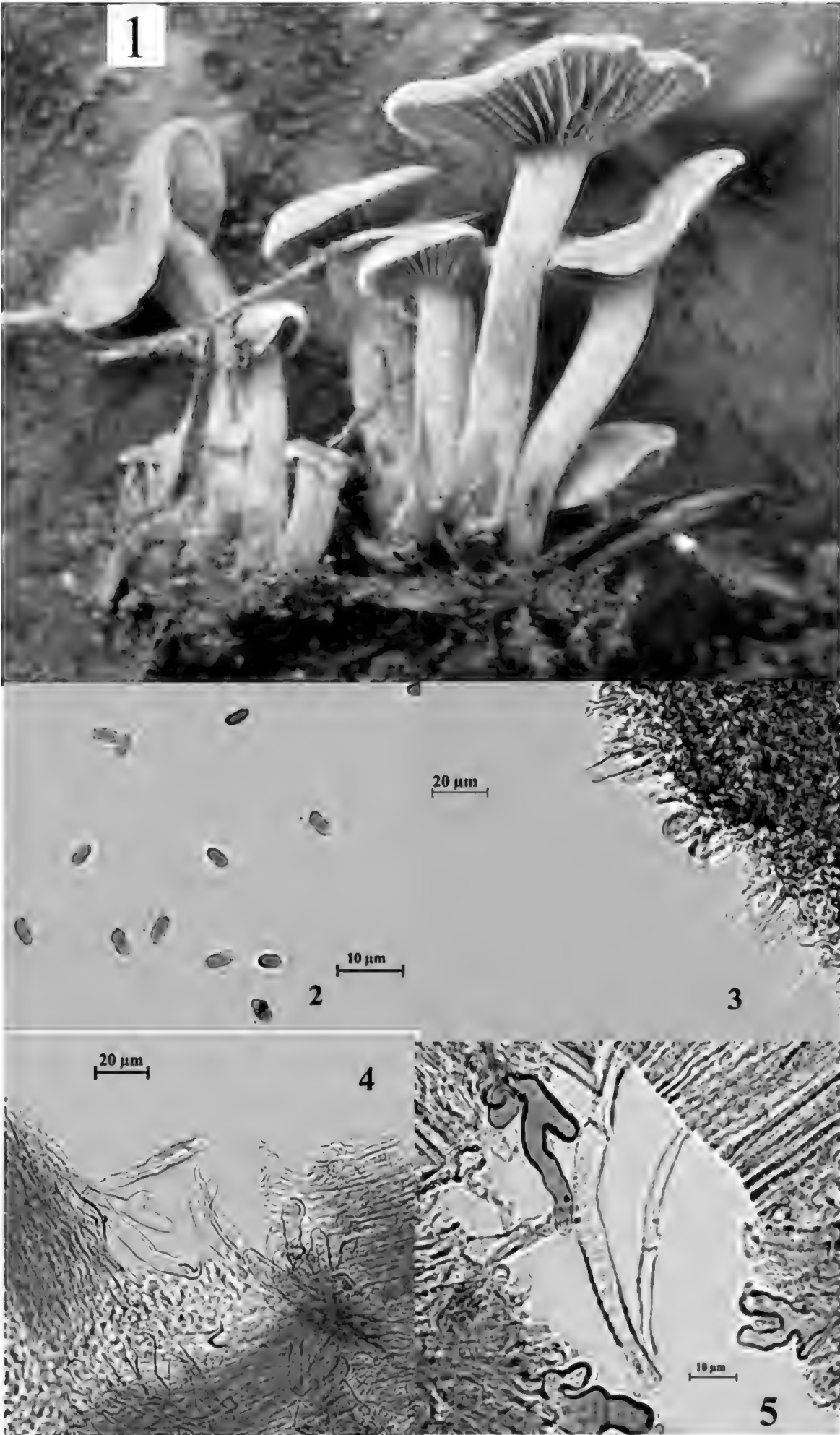


FIG. 6. *Xeromphalina junipericola* distribution.

J. thurifera. In all cases the material has been collected as a saprobe on stumps of different juniper trees. The collecting time was spring (April to May) and autumn (October to December).

In Turkey, a total number of five specimens were collected on different juniper species from four different localities in the southern and central part of the country. In Macedonia the material was collected on a *Juniperus excelsa* stump in a pure juniper forest at an altitude of ~300 m. The species was collected only once, in autumn 2003.

SPECIMENS COLLECTED: **Turkey**—ADANA: Saimbeyli Yatılolu: mixed juniper forest with *Abies cilicica*, on stump of *Juniperus* sp., 1,644 m, 28 October, 2008, leg. H.H. Dogan & M. Karadelev, HD4067; HD 4092. ANKARA: Nallihan — Hosebe parki: pure *Juniperus foetidissima* stand in *Pinus nigra* forest, on stump of *J. foetidissima*, 1,350 m, 12 May, 2005, leg. H.H. Dogan, HD2028. ANTALYA: Elmalı — Ciglikara forest (Sevindik district): pure juniper stand in mixed forest with *Cedrus libani* and *Quercus coccifera*, on stump of *Juniperus excelsa*, 1,400 m, 3 May, 2004, leg. H.H. Dogan, HD1670; Ciglikara forest (Avlan Radyolink way): mixed forest with *Abies cilicica* subsp. *isaurica*, *Cedrus libani* and *Juniperus excelsa*, on stump of *J. excelsa*, 1,400 m, 4 May, 2004, leg. H.H. Dogan, HD1701; Koprulu Kanyon National Park — Dutluca and Ballibucak district: pure *Juniperus excelsa* forest, on stump of *J. excelsa*, 900 m, 23 April, 2005, leg. H.H. Dogan, HD2000. KAYSERİ: Yahyali — Burhaniye village: mixed forest with *Abies cilicica* subsp. *isaurica*, and *J. excelsa*, on stump of *J. excelsa*, 1475 m, 16 April, 2009, leg. H.H. Dogan, HD4611.

Macedonia—VALANDOVO: Chalakli: ass. *Pruno webbii-Juniperetum excelsae*, on stump of *J. excelsa*, 300 m, 13 November 2003, leg. H.H. Dogan & M. Karadelev, MAC34672.

This small and very rare species has an important medical value discovered only recently. Gordon et al. (2007) have extracted a xerocomic acid from a strain of *X. junipericola*. This acid has been identified as HIV-1 IN inhibitor.

Acknowledgements

We are indebted to Vladimír Antonín (Brno, Czech Republic) and Gabriel Moreno (Alcalá de Henares, Spain) for their critical reviews of the manuscript. The research has been supported financially by The Scientific & Technical Research Council of Turkey and the Macedonian Ministry of Science and Education (TUBITAK TOGTAG MKD 2002/1 and TOVAG 106O496).

Literature cited

- Antonín V, Noordeloos ME. 2004. *Hemimycena, Delicatula, Fayodia, Gamundia, Myxomphalia, Resinomycena, Rickenella* and *Xeromphalina* in Europe. IHW Verlag, Eching, Germany.
- Gordon CP, Griffith R, Keller PA. 2007. Control of HIV through the Inhibition of HIV-1 Integrase: A Medicinal Chemistry Perspective. *Medicinal Chemistry* 3(2): 1–40.
- Heykoop M, Moreno G. 2007. Provisional catalogue of the agaricological mycobiota of the province of Guadalajara (Spain). *Bol. Soc. Micol. Madrid* 31: 35–76.
- Moreno G, Heykoop M. 1996. *Xeromphalina junipericola* sp. nov. (*Tricholomataceae, Agaricales*) from Spain. *Z. Mykol.* 62(1): 37–41.
- Moreno G, Prieto F, Heykoop M. 2002. Adiciones al catálogo micológico de la zona centro peninsular. I. *Bol. Soc. Micol. Madrid* 26: 131–145.

A new *Drechslerella* species isolated from *Orbilia* cf. *orientalis*

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Abstract — A new species of the nematode-trapping anamorphic genus *Drechslerella*, *D. yunnanensis*, was isolated from an unidentified *Orbilia* species. *Drechslerella yunnanensis* is characterized by unbranched or occasionally branched conidiophores with conspicuous denticles at the tip and non- to one-septate ellipsoidal conidia. In the presence of nematodes it forms constricting rings.

Key words — nematophagous fungi

Introduction

Subramanian (1964) erected *Drechslerella* for *D. acrochaeta* (Drechsler) Subram. 1964 based on the filiform apical appendage on its conidia. Although Liu & Zhang (1994) synonymized *Drechslerella* with *Monacrosporium* Oudem., detailed molecular analyses (Hagedorn & Scholler 1999) convinced Scholler et al. (1999) to propose new generic concepts for orbiliaceous nematode-trapping fungi based on mode of trapping device. We accept these concepts and recognize *Drechslerella* as characterized by forming three-celled constricting ring traps.

Two *Drechslerella* species have been linked thus far to known teleomorphs, both in *Orbilia*: *D. polybrocha* (Drechsler) M. Scholler et al. 1999 connected to *Orbilia tenebricosa* (Svrček) Baral 2006 and *D. brochopaga* (Drechsler) M. Scholler et al. 1999 connected to *O. orientalis* (Raitv.) Baral 1999 (Pfister 1997, Yu et al. 2006). With our new *Drechslerella* species from China, we describe a third *Drechslerella*-*Orbilia* connection.

Materials and methods

Collection of teleomorph, isolation and characterization of the anamorph

Fresh fruitbodies of an unidentified *Orbilia* sp. were collected by the first author in August 2006 from decaying bark of a broad-leaved tree, Dalongkou Park of Yimen County, Yunnan Province, China (N24°34', E101°00', alt. 1580 m, coniferous-broadleaf

forest dominated by *Cyclobalanopsis glaucoides* Schottky. and *Pinus armandii* Franch.). A dried voucher specimen was deposited in the Laboratory for Conservation and Utilization of Bio-resource, Yunnan Province, China (YMFT 1.01863). Anamorph were isolated by fixing several apothecia to a Petri dish lid of with their hymenia upside down to shoot ascospores on the surface of CMA (20 g corn meal, 18 g agar, 40 mg streptomycin, 30 mg ampicillin, 1000 ml distilled water) according to Yu et al. (2006). Morphological characters of both teleomorph and anamorph were observed and measured with an Olympus B51 microscope with differential interference contrast and a Zeiss Standard 20 microscope. Trapping organs were induced by adding ~100 nematodes (*Panagrellus redivivus* Goodey) into a 1 cm² slot formed by removal of the agar at the colony margin.

DNA extraction, PCR, and sequencing

Total DNA was isolated from fresh mycelium as described by Turner et al. (1997). Primer pairs ITS4 and ITS5 (White et al. 1990) were used to amplify the complete ITS (including 5.8S). PCR amplification parameters followed Yu et al. (2007). The PCR products were purified with a commercial Kit (Biotek Biotechnology Co., Ltd., China) and sequenced on both strands with the same primers that were used for amplification with the aid of a LI-COR 4000L automatic sequencing system, using cycle sequencing with the ThermoSequenase-kit as described by Kindermann et al. (1998).

Phylogenetic analysis

We performed a phylogenetic analysis using ITS sequences of *D. yunnanensis*, morphologically similar species and some species of *Arthrotrrys* Corda and *Dactylellina* M. Morelet. (See PLATE 3 for Genbank accession numbers).

DNA sequences were aligned using Clustalx 1.83. Parsimony analysis was run in PAUP* 4.0b10 (Swofford 2002). Cladistic analyses using the neighbor-joining method were performed with MEGA version 2.1. The neighbor-joining tree was constructed with Kimura 2-parameter model, including transitions and transversions with pairwise gap deletion.

Taxonomy

Anamorph

Drechslerella yunnanensis Z.F. Yu & K.Q. Zhang, sp. nov.

PLATE 1

MYCOBANK MB 512613

Coloniae in agaro albidae, post 10 dies 25°C ad 25 mm diam. Mycelium sparsum, hyphis septatis, 3.5–4 µm latis. Conidiophorae hyalinae, septatae, erectae, 60–220 µm altae, basi 3.8–4.2 µm crassae, sursum leviter fastigiatae, apice 1.5–2 µm crassae, ibi ex denticulis brevibus obtusis saepius 2–7 conidia in capitulum pulchrum radians aggregate ferentes vel subinde usque 10 conidia in parte superiore rarius digesta gerentes. Conidia recta, elongate-ellipsoidea, apice rotundata, basin versus paulo attenuata, 7.8–12.9 longa, 3.3–4 µm crassa.

HOLOTYPE: YMF 1.01863, permanent slide, Yimen County, DaLongkou Forest Park, Yunnan Province, PR China, Ze Fen Yu, Aug. 2006.

TELEOMORPH (origin of isolate): YMFT 1.01863, *Orbilia* cf. *orientalis*, collected on decayed bark of broad-leaved branch.

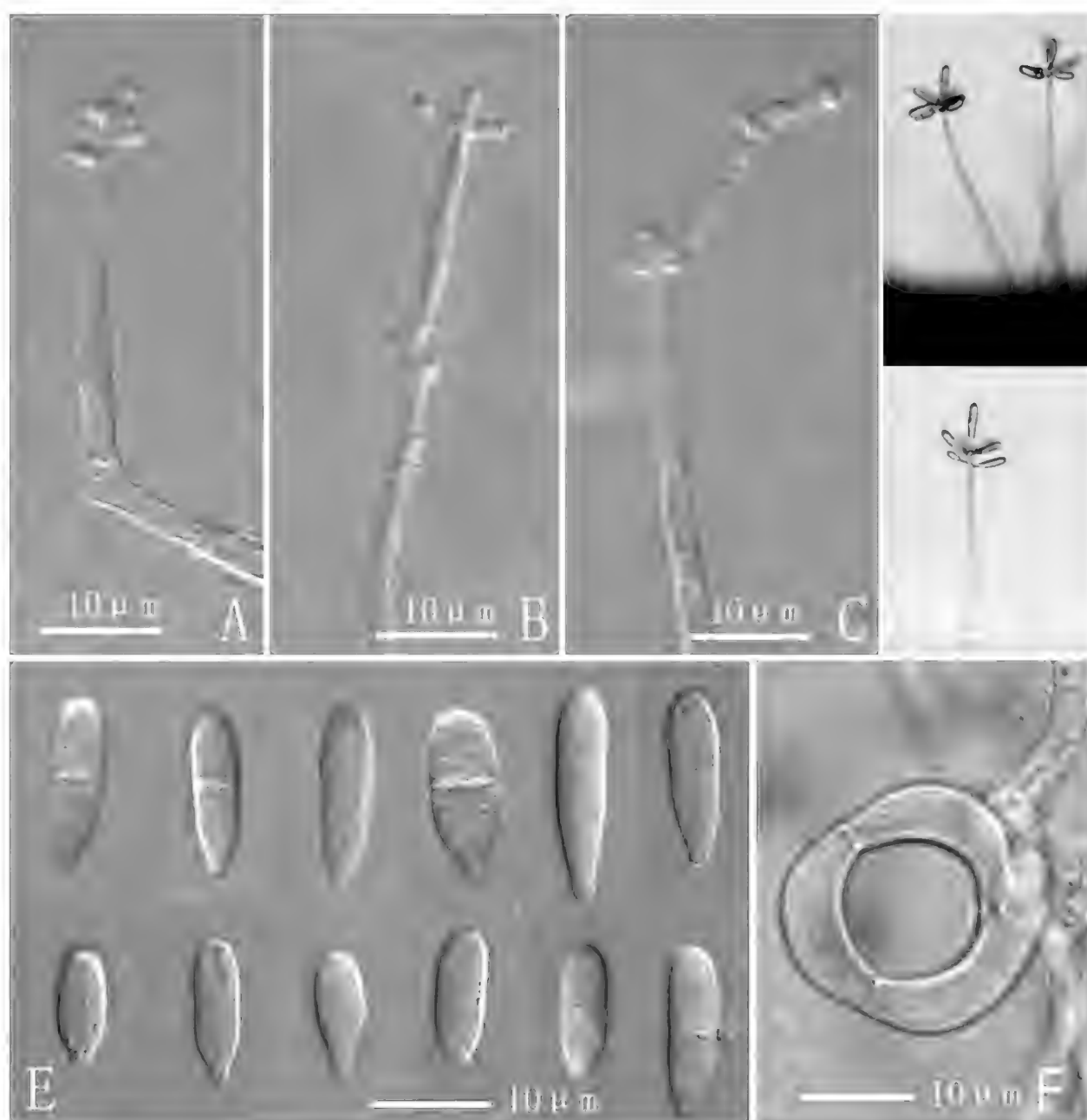


PLATE 1. *Drechslerella yunnanensis* (YMF 1.01863) A–C. Conidiophores with short denticles. D. Conidiophores bearing conidia in clusters. E. Conidia. F. Constricting rings.

ETYMOLOGY: The species epithet refers to the collection site of the teleomorph.

Colonies white, slow-growing on CMA medium, attaining less than 25 mm diam. in 10 days at 25°C. Vegetative hyphae hyaline, septate, 3.5–4 µm wide, aerial mycelium sparse, hyaline, septate, branched, 2.5–4 µm wide. Conidiophores hyaline, septate, erect, unbranched or occasionally branched below, 60–100(–220) µm, 3.8–4.2 µm wide at the base, tapering gradually upward to 1.5–2 µm near the tip, with 2–7(–10) denticles 2.3–4.2 µm long, each bearing one condium in a capitate or racemose arrangement. Conidia hyaline, straight, elongate ellipsoidal, rounded at the apex, with a small truncate protuberance at the base, 7.8–12.9(–17.8) × 3.3–4.2 µm, (0–)1 septate, proportion of aseptate conidia 17%. Nematodes are captured by means of stiped three-celled constricting

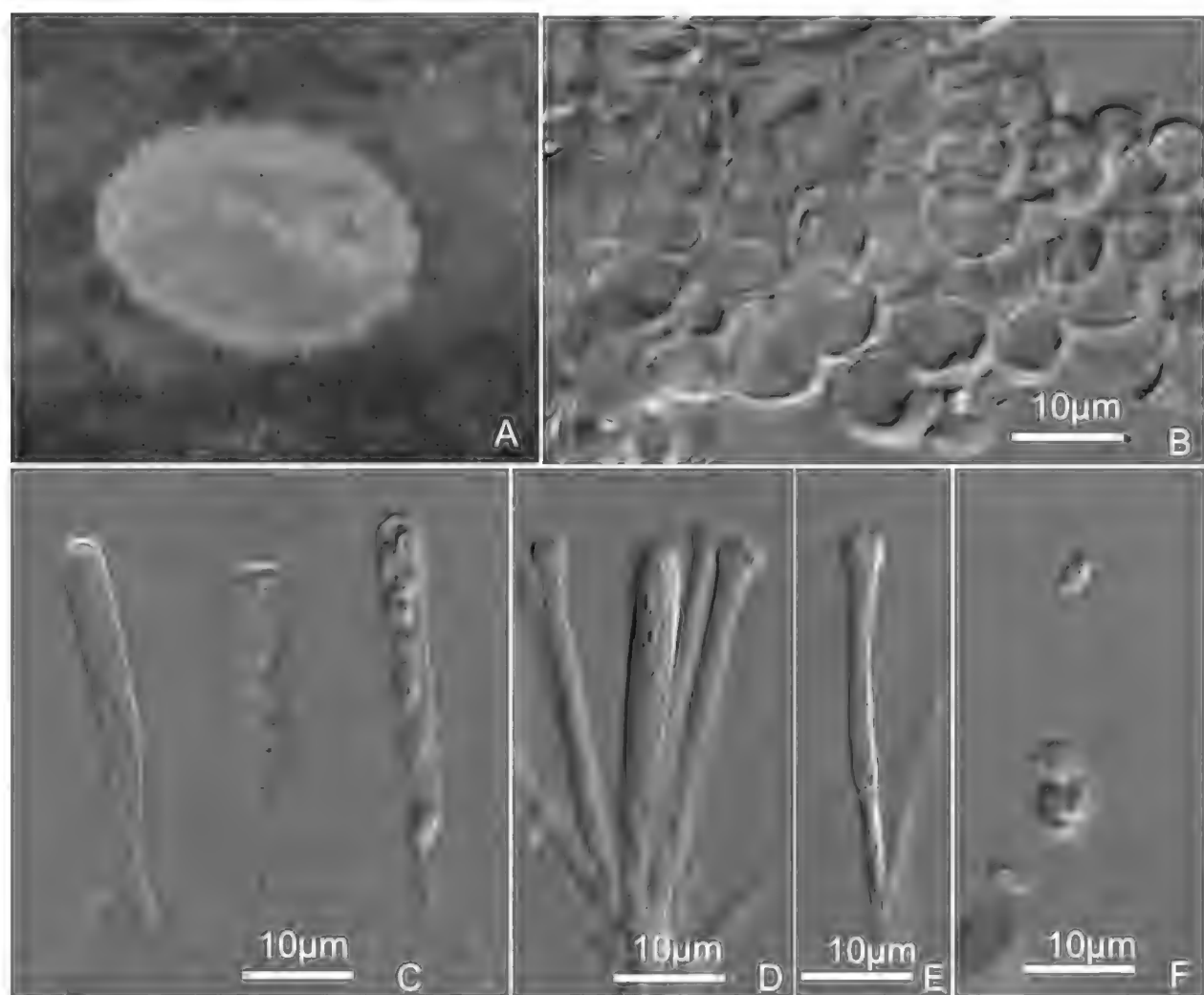


PLATE 2. *Orbilia* cf. *orientalis* (YMFT 1.01863) A. Apothecium. B. Cells of excipulum. C. Asci. D. Cluster of asci and paraphyses. E. Paraphyses. F. Ascospores.

rings. In the non-constricted state, outer diameter measures 18–21.9 µm, the inner one 12–13.6 µm.

Teleomorph

Orbilia cf. *orientalis*

PLATE 2

Phylogenetic analysis

A neighbor-joining tree (PLATE 3) was constructed based on sequences of the ITS region of *D. yunnanensis* and other nematode-trapping fungi, with a non-trapping fungus, *Dactylella clavata* as outgroup. The phylogenetic tree shows the nematode-trapping fungi forming a monophyletic clade that comprises the three subclades corresponding to their trapping devices *Arthrobotrys* (adhesive networks), *Dactylellina* (adhesive knobs), and *Drechslerella* (constricting rings). In the *Drechslerella* clade, *D. yunnanensis* clusters as a species separate from *D. anchonia* (Drechsler) M. Scholler et al. 1999, *D. brochopaga*, and *D. dactyloides* (Drechsler) M. Scholler et al. 1999.

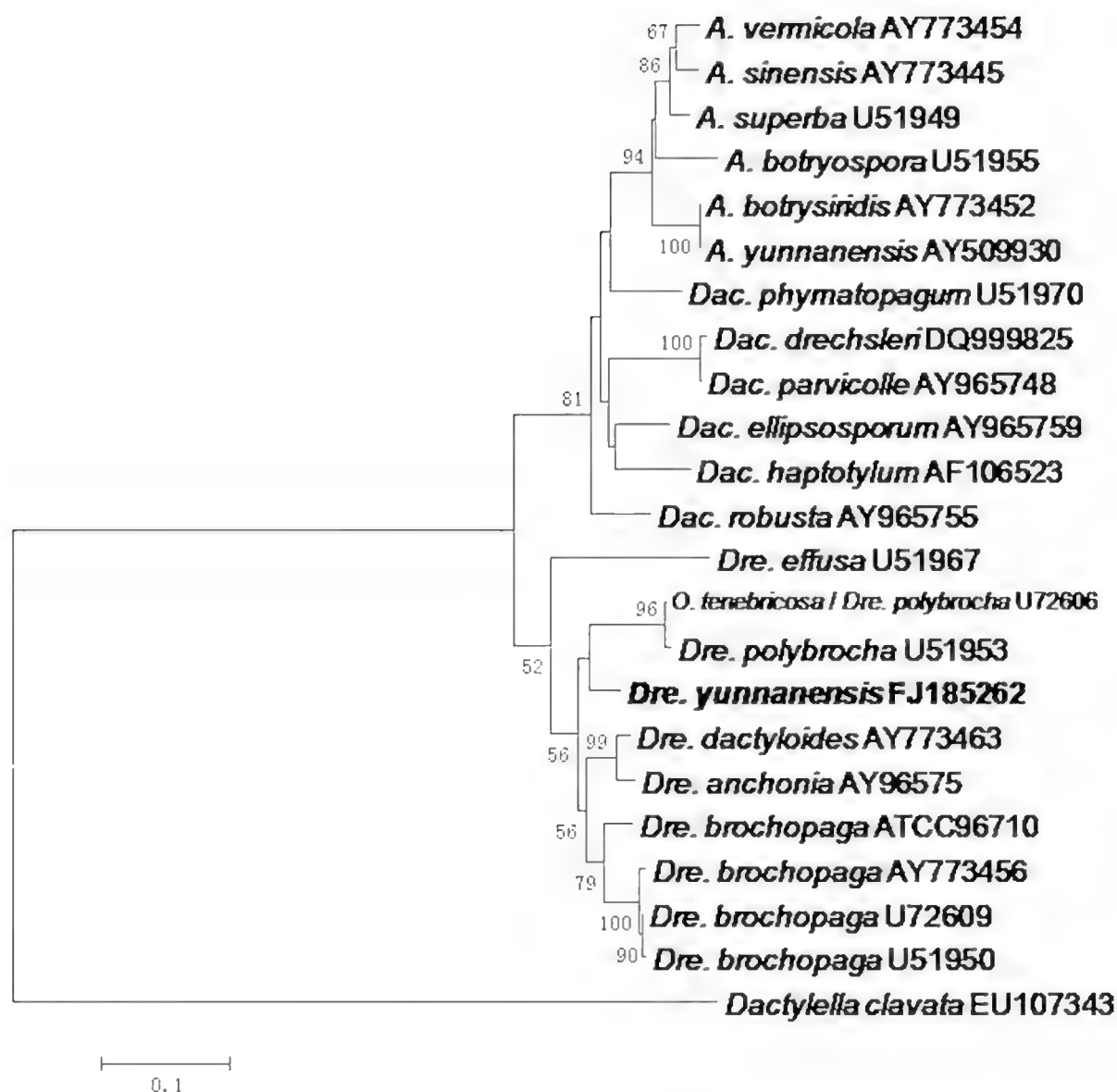


PLATE 3. Phylogenetic tree of *Drechslerella yunnanensis* and related species using the neighbor-joining method based on ITS region sequence data. *Dactylella clavata* was used as outgroup. Bootstrap values less than 50% are not shown.

Discussion

Among the more than 80 nematode-trapping fungal species with trapping devices are 13 known *Drechslerella* species (Scholler et al. 1999), ten of which form only a single terminal conidium on each conidiophore. The most similar species to *D. yunnanensis* in morphology are *D. anchonia*, *D. brochopaga* and *D. dactyloides*, all of which have more than one conidium at the tip of the conidiophores in a capitate arrangement.

In addition, *D. brochopaga* has much larger conidia ($26\text{--}46 \times 5\text{--}9 \mu\text{m}$) with more (mainly 3) septa (Drechsler 1937), and *D. anchonia* has obovoid, much larger conidia ($29\text{--}43\text{--}35 \times 15\text{--}19\text{--}16.8 \mu\text{m}$) with a single septum in the lower third (Drechsler 1954). Conidia of *D. dactyloides* are narrowly ellipsoidal

or somewhat digitiform, often very slightly curved, with more conidia in the apex of conidiophores, and much larger ($32\text{--}48 \times 7\text{--}9.5 \mu\text{m}$; Drechsler 1937).

The teleomorph of *D. yunnanensis* is very similar to *O. orientalis* in having cylindric-ellipsoid ascospores with a refractive, rod-shaped, laterally arranged spore body (SB) at the upper end. Also spore size is very close (protologue of *O. orientalis*: $3\text{--}4 \times 1.5\text{--}2 \mu\text{m}$, our specimen: $4.0\text{--}4.2 \times 1.6\text{--}1.9 \mu\text{m}$). The apothecial margin is only minutely crenulate and hardly bears any glassy processes, while in the *O. orientalis* type, the glassy processes are long and agglutinated, forming distinct teeth at the margin. In the phylogenetic analysis, the teleomorph of *D. yunnanensis* clusters quite far from *D. brochopaga*, although the bootstrap values are low. The ITS similarity between *D. yunnanensis* and *D. brochopaga* (ATCC 96710) is only 87.35, and that between each of other three *D. brochopaga* strains (Genbank accession numbers: AY773456, U51950, U72609) is 86.15, 86.56, and 85.11 respectively, suggesting that *D. yunnanensis* is a species different from *D. brochopaga*. Since we could not identify the teleomorph as a new species based on the limited morphological characters available, we assigned it to *O. cf. orientalis*.

Acknowledgements

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Literature cited

- Drechsler C. 1937. Some hyphomycetes that prey on free-living terricolous nematodes. *Mycologia* 29: 447–552.
- Drechsler C. 1954. Some hyphomycetes that capture eelworms in southern states. *Mycologia* 46: 762–782.
- Hagedorn G, Scholler M. 1999. Revaluation of predatory orbiliaceous fungi. I. Phylogenetic analysis using rDNA sequence data. *Sydowia* 51: 27–48.
- Kindermann J, EL-Ayouti Y, Samuels GJ, Kubicek CP. 1998. Phylogeny of the genus *Trichoderma* based on sequence analysis of the internal transcribed spacer region 1 of the rDNA clade. *Fungal Genetic Biology* 24: 298–309.
- Liu XZ, Zhang KQ. 1994. Nematode-trapping species of *Monacrosporium* with special reference to two new species. *Mycologia Research* 98(8): 862–868.
- Pfister DH. 1997. Castor, Pollux and life histories of fungi. *Mycologia* 89: 1–23.
- Scholler M, Hagedorn G, Rubner A. 1999. A reevaluation of predatory orbiliaceous fungi. II. A new generic concept. *Sydowia* 51: 89–113.
- Subramanian CV. 1964 (“1963”). *Dactylella*, *Monacrosporium* and *Dactylina*. *J. Indian Bot. Soc.* 42: 291–300.
- Swofford DL. 2002. PAUP*. Phylogenetic analysis using parsimony, Version 4.0. Sinauer Associates, Sunderland, Massachusetts, USA.

- Turner D, Kovacs W, Kuhls K, Lieckfeldt E, Peter B, Arisan-Atac I, Strauss J, Samuels GJ, Börner T, Kubicek CP. 1997. Biogeography and phenotypic variation in *Trichoderma* sect. *Longibrachiatum* and associated *Hypocrea* species. *Mycological Research* 101: 449–459
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: *PCR Protocols: a guide to methods and applications*. Academic Press, San Diego, CA. pp. 315–322.
- Yu ZF, Zhang Y, Qiao M, Baral HO, Weber E, Zhang KQ. 2006. *Drechlerella brochopaga*, the anamorph of *Orbilina* (*Hyalinia*) *orientalis*. *Mycotaxon* 96: 163–168.
- Yu ZF, Zhang Y, Qiao M, Zhang KQ. 2007. *Orbilina dorsalia* sp. nov., the teleomorph of *Dactylella dorsalia* sp. nov. *Cryptogamie, Mycologie* 28: 289–294.

A new species and new combinations in the corticioid genus *Gloiothele* (Basidiomycota)

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Abstract — A new corticioid fungus with smooth, globose, amyloid spores is described. *Gloiothele ventricosa* sp. nov. is characterized by its smooth hymenophore, ventricose gloeocystidia, globose to subglobose basidiospores with amyloid walls, and numerous hyphidia. The affinities to some other species in the genus and related genera are discussed and illustrations are given. Examination of the type specimen of *Gloiothele torrendii* suggests a placement in *Leptocorticium*, and the new combination *Leptocorticium torrendii* is proposed. *Gloeocystidiellum orientale* is resurrected and the new combination *Gloiothele orientalis* is proposed. A lectotype for *Flavophlebia sulfureoisabellina* is designated.

Key words — *Amylofungus*, *Gloiothele globosa*, lectotypification, taxonomy, *Vesiculomyces*

Introduction

The genus *Gloiothele* Bres. is composed of monomitic, clampless corticioid species with sulfopositive gloeocystidia and smooth, amyloid spores (Wu 1996b, Boidin et al. 1997). In a recent key by Hjortstam & Ryvar den (2005), the genus currently comprises 12 species. A closely related genus, *Vesiculomyces* E. Hagstr., is separated by the absence of sulfovanillin reaction in gloeocystidia (cf. Boidin & Lanquetin 1983, but also Larsson & Larsson 2003). Although *Vesiculomyces citrinus* (Pers.) E. Hagstr. 1977 shows a close relationship to some *Gloiothele* species in molecular studies, Larsson & Larsson (2003) and Miller et al. (2006) retain *Vesiculomyces* as distinct from *Gloiothele*. The creditability of sulfovanillin reaction as the mere character for distinguishing the two genera may be addressed with more comprehensive molecular tests.

Amylofungus Sheng H. Wu was originally described (Wu 1996a) to accommodate *Gloeocystidiellum corrosu m* (G. Cunn.) Stalpers 1985 (=

Vesiculomyces corrosus (G. Cunn.) Hjortstam 1995). The two species in the genus possess all diagnostic characters of *Gloiothele* with the added distinction of the amyloid reaction extending to the entire hymenophore. *Amylofungus* has not been included in a phylogenetic study to clarify its relationship to *Gloiothele* and *Vesiculomyces*.

Several *Gloiothele* species have globose-subglobose spores, among them being *Gloiothele globosa* Sheng H. Wu 1996 which was originally described on a single collection from Taiwan (Wu 1996b). Later, Boidin et al. (1997) reported this species from Réunion based on six specimens. During a study on these specimens and comparisons with the type of *G. globosa* and additional material, an undescribed *Gloiothele* species was uncovered that is described here (no. 14441, illustration also given by Boidin et al. 1997: 47). Moreover, several other corticioid species with gloeocystidia and globose spores came to the attention, and examination of their type specimens resulted in two new combinations and a lectotypification.

Materials and methods

Specimens were studied in 5% potassium hydroxide (KOH), Melzer's reagent (IKI) and Cotton Blue in lactic acid (CB) (see e.g. Largent et al. 1977). Sulfovanillin (SV) reagent (vanillin crystals in 80% sulphuric acid) was also used to examine the possible reaction of gloeocystidia (cf. Larsson & Larsson 2003). Measurements and drawings were made in CB using the light microscope. Line drawings were aided by a drawing tube. Spore measurements are based on at least thirty spores measured. The following abbreviations are used: L = length range, W = width range, Q = range of variation in L:W ratio. In each range, the values in the parentheses are 10 % of variation extremes.

Species description

Gloiothele ventricosa Ghobad-Nejhad sp. nov.

FIGS. 1–2.

MYCOBANK MB 49747

Basidiocarpum resupinatum, effusum, lignicolor, ceraceum, adnatum, 80–150(–200) µm crassum; superficies hymenialis plana. Systema hypharum monomiticum, efibulatum. Gloeocystidia numerosa, ventricosa, (15–)50–90(–115) × (7–)9–11(–15) µm, SV+. Hyphidiae numerosae. Basidiosporae globosae vel subglobosae, laeves, 5.9–7.1(–8.0) × (5.0–)5.3–6.7(–7.3) µm, amyloideae.

HOLOTYPE — Réunion: Notre Dame de la Paix I, on decorticated, fallen trunk “of angiosperm”, 10 April 1990 legit Boidin 14441 (LY).

ETYMOLOGY — the epithet *ventricosa* refers to the shape of gloeocystidia base.

BASIDIOCARP effuse, ceraceous, closely adnate, wood-colored, pale mouse-grey with a brownish tint, more or less soft in consistency, 80–150(–200) µm thick. Hymenophore smooth, irregularly and indistinctly tuberculate following the

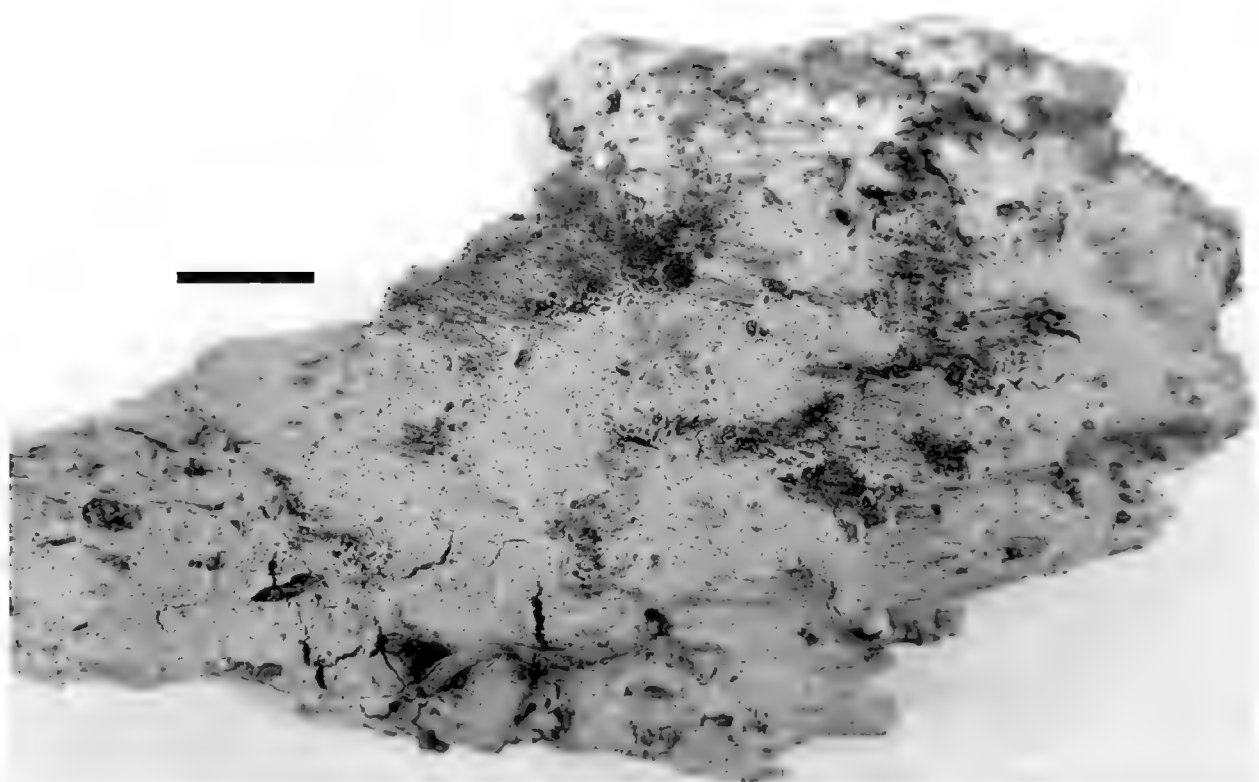


FIG. 1. Basidiocarp of *Gloiothele ventricosa* sp. nov. from holotype. Scale bar = 1 cm.

surface of the substrate, slightly cracked upon drying, pruinose under lens 16 \times . Margin thinning out, indistinct, concolorous with the hymenophore. HYPHAL SYSTEM monomitic, simple septate, pale yellowish to hyaline when examined in KOH, thin-walled, distinct (only little intricate and agglutinated in subhymenium), 1.7–2 μm in diameter, without oily exudate or crystal particles. Upper hymenial elements with slightly cyanophilous walls. Hyphae in lower subhymenium and subiculum more brownish than the rest of the hyphae. Subiculum indistinct. GLOEOCYSTIDIA numerous, embedded, $L \times W = (15\text{--}50\text{--}90\text{--}115) \times (7\text{--}9\text{--}11\text{--}15)$ μm , arising mostly from subiculum or subhymenium, extending up to the hymenium, not or only slightly projecting, ventricose at the base especially when young, less conspicuously so when mature, little flexuous, occasionally more or less cylindrical, attenuate at apex, contents pale yellowish brown, richly granulate to homogenous in KOH, contents shrunk when seen in IKI, weakly SV+ (light brown). Few hyaline, fusoid cystidia also present, projecting up to 30 μm above the hymenium. HYPHIDIA abundant, 1.7–2.5 μm wide, only slightly projecting, sparsely branched at apex. BASIDIA clavate to subcylindrical, slightly constricted in the middle, $L \times W = 33\text{--}46\text{--}55 \times (4.5\text{--}5.5\text{--}7)$ μm , basally simple septate, with oily granules in their content, four-sterigmate, sterigmata 4–4.5 μm in length. BASIDIOSPORES globose to subglobose, $L \times W = 5.9\text{--}7.1\text{--}8.0 \times (5.0\text{--}5.3\text{--}6.7\text{--}7.3)$ μm , $L_{\text{mean}} = 6.68$ μm , $W_{\text{mean}} = 5.96$ μm , $Q = 1.00\text{--}1.2\text{--}1.27$, $Q_{\text{mean}} = 1.12$, with a large, distinct, lateral apiculus, contents pale yellow from oil granules, with a large hyaline guttule when examined in CB, walls smooth, thin, CB– or weakly CB+, amyloid.

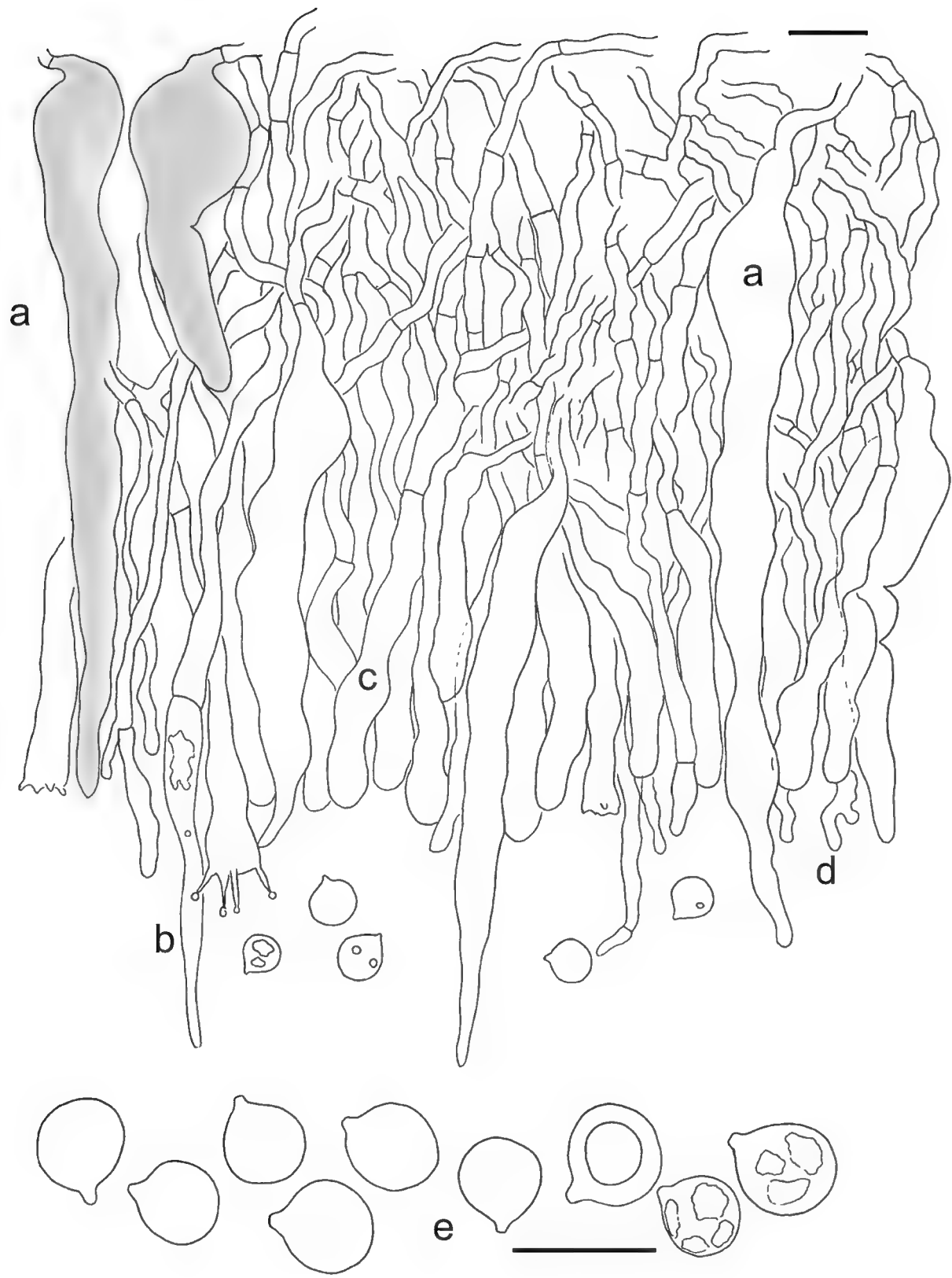


FIG. 2. A section of *Gloiothele ventricosa* drawn from holotype.
a) Gloeocystidia (two filled as exemplar), b) fusoid cystidia, c) basidia, d) hyphidia, e) spores.
Scale bar = 10 μ m.

ADDITIONAL SPECIMENS STUDIED—*Gloiothele citrinoidea* (TYPUS). **Taiwan.** Taipei, Taipei Botanical Garden, on on sheath culm of *Phoenix dactylifera*, 27.VI.1992 Wu 9206–78 (TNM!).

Gloiothele globosa (TYPUS). **Taiwan**. Nantou, Chitou, alt. 1250 m, on branch of *Cryptomeria japonica*, 17.V.1991 Wu 910517–25 (TNM!).

Poria lamellosa Henn. 1904 (TYPUS). **Tanzania**. On trunk, 1899 Kummer 54, (S!).

Thelephora lactescens Berk. 1836 (TYPUS). **England**. Nottinghamshire, Clifton, on wood, 1836 Berkeley [British Fungi 1836–1843, no. 21] (K!).

Vesiculomyces citrinus. **Estonia**. Saaremaa, Odalätsi landscape protection area, on fallen log in mixed forest with *Pinus sylvestris*, 19.IX.2008 Ghobad-Nejhad 1756 (Ghobad-Nejhad ref. herb., dupl. in H).

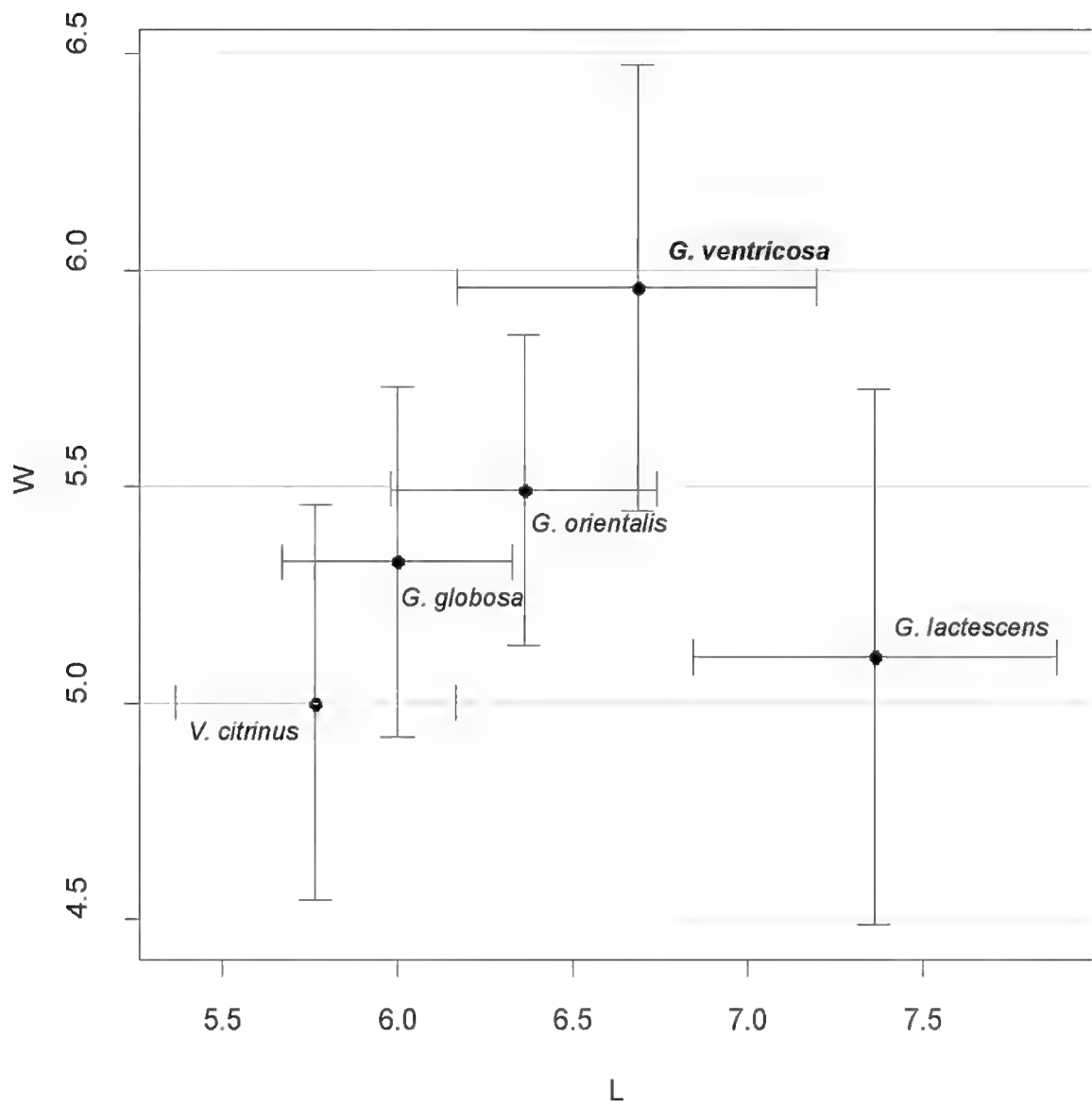


FIG. 3. Comparison of spore sizes (μm) in *Gloiothele ventricosa* with four closely related species. All measurements, except for *V. citrinus*, are from type material.

COMMENTS: With regard to spore morphology, *G. ventricosa* is comparable to *Gloiothele* species with globose spores. *Gloiothele globosa* has smaller spores (FIG. 3) and differs also by its “yellowish white” hymenophore growing on corticated wood, fibrillose margins, and cylindrical gloeocystidia (see also

Wu 1996b). In *Gloiothele granulosa* Hjortstam & Spooner 1990, the hymenophore is granulose and spores are much smaller than in the new species (Hjortstam et al. 1990). Moreover, its gloeocystidia are widest in the middle, while they are most often broader at their lower part in *G. ventricosa*. *Gloiothele citrinoidea* Sheng H. Wu 1996 has short, clavate gloeocystidia arising from the hymenium (see also Wu 1996b).

The two species now accommodated in the genus *Amylofungus* have a spore shape very similar to *G. ventricosa*, but they differ primarily by their thoroughly amyloid hymenial elements. Moreover, *A. corrosus* (G. Cunn.) Sheng H. Wu 1996 has clavate gloeocystidia and smaller spores, and *A. globosporus* (N. Maek.) Sheng H. Wu 1997 has cylindrical gloeocystidia and its reported spore size is larger than in *G. ventricosa* (see Wu 1966a and 1997).

Vesiculomyces citrinus also possesses globose, amyloid spores and ventricose gloeocystidia. However, it already differs by having membranaceous hymenophore with citrinoid color, empty, hymenial cystidia (SV–), and smaller spores (FIG. 3).

As far as the abundant hyphidia and closely adnate hymenophore are concerned, *G. ventricosa* reminds of *Gloiothele lactescens* (Berk.) Hjortstam 1987. However the latter has ellipsoid spores (Fig. 3) and very long, cylindrical gloeocystidia. In addition, the hymenophore in *G. lactescens* is hard, usually cracking characteristically when aged (Eriksson & Ryvarden 1975).

Globose spores have also been mentioned for *Gloiothele torrendii* (Bres.) Boidin & H. Michel 1997. Examination of the holotype of *Corticium torrendii* (FIG. 4) shows that it is quite different from *Gloiothele* species. The specimen has a fragile, pruinose fruitbody (cracked in small polygons), richly branched hyphae with frequent clamps, urniform basidia, numerous crystallized dendrohyphidia, and hymenial gloeocystidia devoid of oil granules. Spores lack oily contents and do not react with IKI. These characters can potentially indicate a placement in *Leptocorticium* Hjortstam & Ryvarden, and the new combination is proposed below (see Nakasone 2005 for genus emendation).

***Leptocorticium torrendii* (Bres.) Ghobad-Nejhad comb. nov.**

FIG. 4

MYCOBANK 514029

BASIONYM—*Corticium torrendii* Bres., Atti Acad. Agiata Rovereto 8(2): 131 (1902).

HOLOTYPE—Portugal. Setúbal, on branch of *Olea europaea*, no date, Torrend s.n. (S, F14595!).

The specimen studied here has Bresadola's handwritten description that is identical to the protologue. No reference to a type material could be found in the publication by Boidin & Michel (1997).

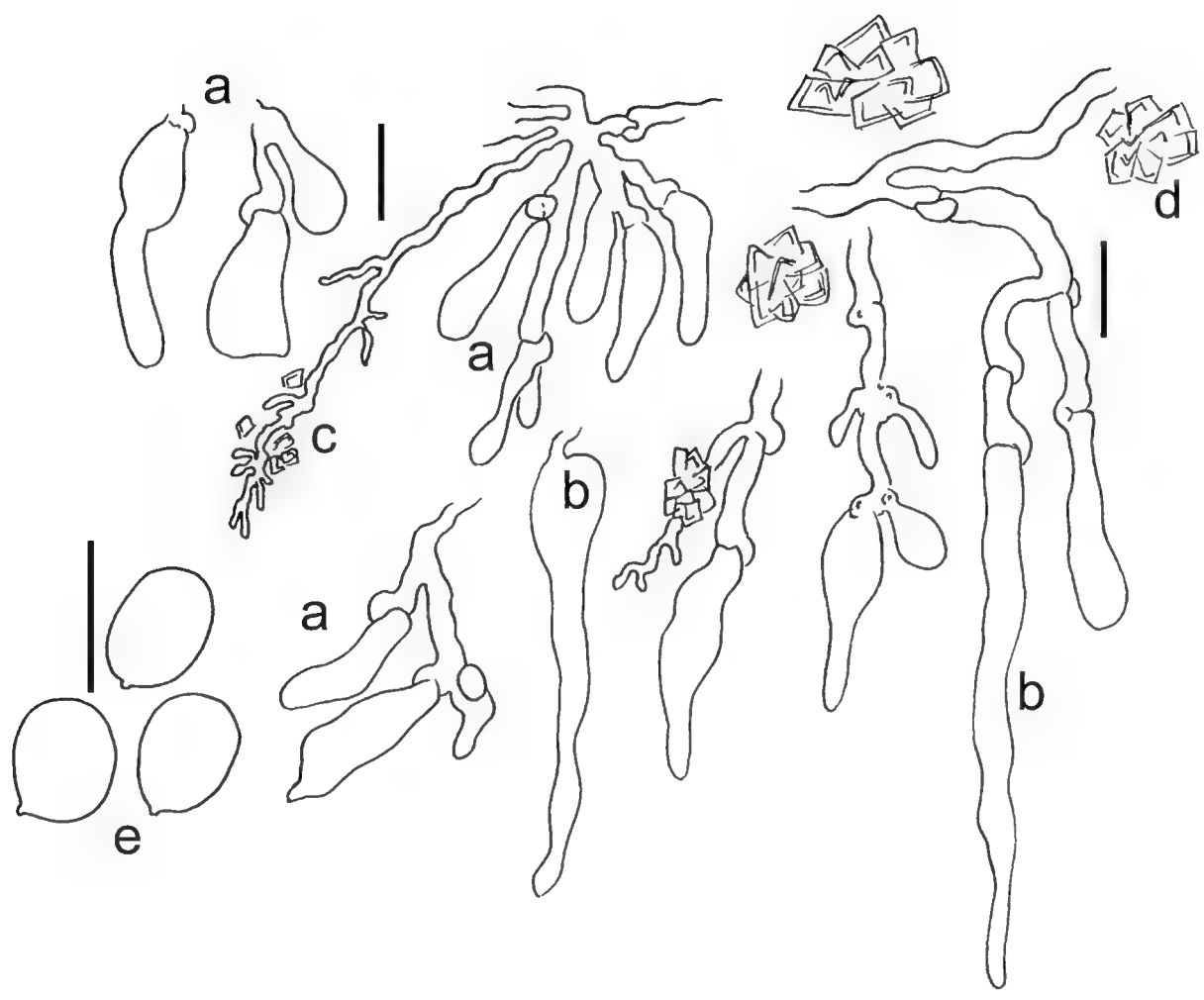


FIG. 4. A section of *Corticium torrendii* drawn from holotype.
a) Basidia in different stages of development, b) gloeocystidia, c) dendrohyphidia,
d) crystals, e) spores. Scale bar = 10 µm.

Very similar spore morphology is also assumed in *Gloeocystidiellum orientale*, a little known species with amyloid, globose spores, described by Parmasto (1965) from a single specimen collected by him in Russian Far East. Eriksson & Ryvardeen (1975) raised the question whether this species is only a young form of *Gloeocystidiellum lactescens* (Berk.) Boidin 1951, and later Wu (1996b: 6) pointed out its possible affinity to the genus *Gloiothele*. An examination of the isotype of *G. orientale* at GB confirms that it is a species of *Gloiothele*. It has sulfovanillin positive gloeocystidia (they are brown, with a bluish tint), and is distinct from *G. lactescens* by its much thinner, detachable basidiocarp, as well as developing fewer and shorter gloeocystidia (also stated in protologue). Therefore the following new combination is proposed.

***Gloiothele orientalis* (Parmasto) Ghobad-Nejhad comb. nov.**

FIG. 5

MYCOBANK 514028

BASIONYM—*Gloeocystidiellum orientale* Parmasto, Eesti N.S.V. Tead. Akad. Toimet., Biol. 14(2): 225 (1965).

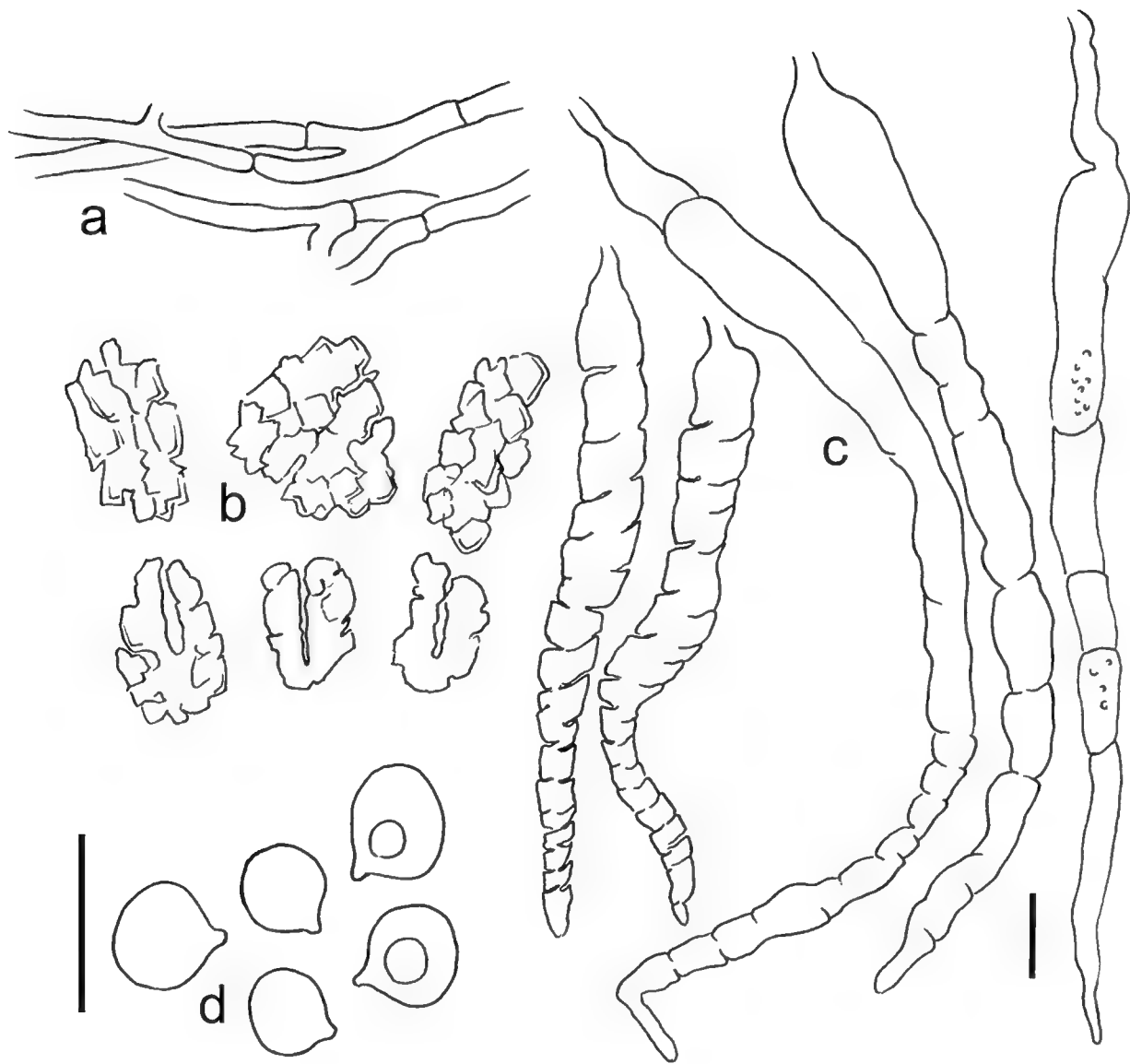


FIG. 5. A section of *Gloecystidiellum orientale* drawn from holotype.
a) Hyphae, b) crystal aggregations, c) cystidia with highly shrunk contents, d) spores.
Scale bar = 10 μ m.

HOLOTYPE—Russia. Regio Primorsk: Reservatum Suputinka, on *Maackia amurensis*, 1961 Parmasto 14673 (GB, isotype!).

The studied specimen bears hyphal ends with loose encrustations (FIG. 5), which easily can be overlooked if the section is firmly squashed. These structures are present in the generitype, *Gloiothele lamellosa* (Henn.) Bres. 1920, but are smaller and formed only in upper hymenium on dissepiment edges, while in *G. orientalis* they are larger, and embedded. Gloecystidial contents are pale yellow in KOH and contracting in CB mounts. Fruitbody structures are generally acyanophilous (CB–). *Gloiothele humilis* (Boidin) Boidin, et al. 1997 apparently has a hymenophore similar to *G. orientalis* (Boidin 1966, Boidin et al. 1997), and has encrusted hyphal ends and brown sulfovanillin reaction of gloecystidia (Hjortstam & Ryvarden 2005). However, no material of this species was available for close comparison in the present study.

Lectotypification

Flavophlebia sulfureoisabellina (Litsch.) K.H. Larss. & Hjortstam (1977)

Flavophlebia (Parmasto) K.H. Larss. & Hjortstam is a monotypic genus erected by Hjortstam & Larsson (1977) for *Corticium sulfureoisabellinum* Litsch (Pilát 1940). Dämon (1998) provided detailed notes on its history of taxonomy, ecology, and general distribution.

SPECIMENS STUDIED—*Corticium sulfureoisabellinum* (TYPUS). Czech Republic. Ivan, Bílý Potok, Strunžín near Trebušany, on decayed trunk of *Abies alba*, VIII.1935 Pilát 19741 (PRM! lectotype designated here). Russia. Krasnodar: Caucasus Nature Reserve, Umpyr, alt. 1500 m, on *Abies nordmanniana*, 12.IX.1991 Kõljalg (159011 TAA). Poland. Sucha Beskidzka, Babia Góra National Park, on *Abies*, 15.IX.1973 Hallenberg & Larsson (2645 GB).

In the original description of *C. sulfureoisabellinum* (Pilát 1940: 43), five specimens were mentioned from the same locality viz. nos. 19471, 19472, 20141, 20442, and 20428, deposited in Herbarium Musei Nationalis Pragae (PRM), but no holotype was designated. In his detailed description of the species, Jackson (1948) mentioned a studied type in TRT, without a number. None of the studies on the species made afterwards (summarized by Dämon 1998) concerned the type examination. In order to prevent probable confusion and facilitate further communications concerning this species, PRM specimen no. 19741 is designated here as lectotype.

Acknowledgments

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Literature cited

- Boidin J. 1966. Basidiomycètes *Corticaceae* de la République Centrafricaine. Cah. Maboké 4: 5–17.
- Boidin J, Lanquetin P. 1983. Basidiomycètes *Aphylllophorales* épitheloïdes étales. Mycotaxon 16: 461–499.
- Boidin J, Lanquetin P, Gilles G. 1997. Le genre *Gloeocystidiellum* sensu lato (*Basidiomycotina*). Bull. Soc. Mycol. France 113: 1–80.
- Boidin J, Michel H. 1997. *Gloiothele torrendii* (Bres.) nov. comb. (*Basidiomycotina*, *Aphylllophoromycetidae*), nouveau pour la France. Bull. Soc. Mycol. France 113: 95–97.
- Dämon W. 1998. Corticioide Basidienpilze Österreichs 2. Österr. Z. Pilzk. 7: 135–189.

- Eriksson J, Ryvar den L. 1975. The *Corticaceae* of North Europe. Vol. 3. *Coronicium–Hyphoderma*. Fungiflora, Oslo.
- Hjortstam K, Larsson KH. 1977. Notes on *Corticaceae* (basidiomycetes). Mycotaxon 5: 475–480.
- Hjortstam H, Ryvar den L. 2005. Studies in corticioid fungi from Venezuela II (*Basidiomycotina*, *Aphylllophorales*). Synopsis Fungorum 20: 42–78.
- Hjortstam K, Spooner BM, Oldridge SG. 1990. Some *Aphylllophorales* and heterobasidiomycetes from Sabah, Malaysia. Kew Bull. 45: 303–322.
- Jackson HS. 1948. Studies of Canadian *Thelephoraceae*. II. Some new species of *Corticium*. Canad. J. Res. Sect. C, Bot. Sci. 26: 133–152.
- Largent DL, Johnson D, Watling R. 1977. How to identify mushrooms to genus III: Microscopic features. Eureka, CA. Mad River Press. 145 pp.
- Larsson E, Larsson KH. 2003. Phylogenetic relationships of russuloid basidiomycetes with emphasis on aphylllophoralean taxa. Mycologia 95: 1037–1065.
- Miller SL, Larsson E, Larsson KH, Verbeken A, Nuytinck J. 2006. Perspectives in the new *Russulales*. Mycologia 98: 960–970.
- Nakasone K. 2005. *Leptocorticium* (*Corticaceae* s.l., *Basidiomycota*): New species and combinations. Mycological Progress 4: 251–256.
- Parmasto E. 1965. *Corticaceae* URSS. I. Descriptiones taxorum novarum. Combinationes novae. Eesti N.S.V. Tead. Akad. Toimet., Biol. 14: 220–233.
- Pilát A. 1940. Hymenomycetes Carpatorum orientalium. Sborn. Nár. Mus. Praze, Řada B, Přír. Vědy 2: 37–80.
- Wu SH. 1996a (“1995”). Two new genera of corticioid basidiomycetes with gloecystidia and amyloid basidiospores. Mycologia 87: 886–890.
- Wu SH. 1996b. Studies on *Gloeocystidiellum* sensu lato (*Basidiomycotina*) in Taiwan. Mycotaxon 58: 1–68.
- Wu SH. 1997. Two new combinations: *Amylofungus globosporus* and *Gloeomyces moniliformis*. Mycotaxon 64: 321–364.

***Crepidotus kubickae* – a forgotten name**

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Abstract — Study and analysis of type and other specimens of *Crepidotus kubickae* and related taxa support the name as a distinct species.

Key words — *Basidiomycota*, *Inocybaceae*, taxonomy, nomenclature

Introduction

Only a few authors have used the name *Crepidotus kubickae*, originally described by Pilát (1949). In her monograph, which included a type study of *C. kubickae*, Senn-Irlet (1992) stated that the type represented only a variant of *C. cesatii* (Rabenh.) Sacc. 1877; she later (Senn-Irlet 1995) placed the name *C. kubickae* into synonymy with *C. cesatii* var. *subspheerosporus*. Horak (2005) proposed *C. kubickae* as a synonym for *C. subepibryus* Pilát 1949.

One reason why *C. kubickae* is almost a forgotten name today may be that most recent authors (e.g., Comesaña & Castro 2000, Gerault 2005, Gonou-Zagou & Delivorias 2005, Roux 2006, Walley & Vandeveen 2006) have followed Senn-Irlet's taxonomic concept for *Crepidotus*. Currently only Pouzar (2005) regards *C. kubickae* as a correct name.

In this paper, *C. kubickae* is accepted at the species rank; the characters supporting its independent status are presented.

Material and methods

The study is based on examination of 41 specimens of *Crepidotus* that include type and recent material. All studied specimens are those from the herbaria G, KRAM, PRM, and SLO. Data on specimens are not updated.

The microscopical structures were observed in dried material. The microscopical slides were prepared with 5% aqueous solution of KOH and a solution of Congo Red in ammonia (1 ml of 25% ammonia added in filtrated solution of 1.5 g of Congo Red in 50 ml of distilled water). The colours of microstructures were examined in KOH; the measurements were made under Congo Red. For the measurements (30 per specimen) of microcharacters (spores, cheilocystidia and basidia) min, max (in the parenthesis) and average +/- standard deviation values are presented. Q is ratio of length and width

of spores. Photomicrographs of the spores were made under the light Olympus BX41 microscope (LM) and scanning electron microscope (SEM). Morphological terms follow Vellinga (1988). The description of macrocharacters is brief and based only on the collectors' notes (no fresh material was available). Data on ecology are based on the "Specimens examined".

Taxonomic description

Crepidotus kubickae Pilát, Stud. Bot. Čechoslov. 10: 150, 1949

= *Crepidotus variabilis* var. *subsphaerosporus* J.E. Lange, Fl. Agaric. Danic. 5: IV, 1940

"*Crepidotus variabilis* var. *subsphaerosporus*" J.E. Lange, Dansk Bot.

Ark. 9(6): 52, 1938, nom. inval. (Vienna Code, Art. 36.1)

"*Crepidotus variabilis* var. *subsphaerosporus*" J.E. Lange, Fl. Agaric.

Danic. 4: 46, 1939, nom. inval. (Vienna Code, Art. 36.1)

"*Crepidotus subsphaerosporus*" (J.E. Lange) Kühner & Romagn., Fl. Analyt.

Champ. Supér. (Paris), p. 76, 1953, nom. inval. (Vienna Code, Art. 33.4)

"*Crepidotus subsphaerosporus*" (J.E. Lange) Kühner & Romagn. ex Hesler & A.H.

Sm., N. Amer. Sp. *Crepidotus*, p. 121, 1965, nom. inval. (Vienna Code, Art. 33.7)

= *Crepidotus cesatii* var. *subsphaerosporus* (J.E. Lange)

Senn-Irlet, Persoonia 16: 53, 1995

MACROCHARACTERS — **PILEUS** 0.5–4 cm, irregularly circular, rounded flabelliform or reniform, convex, plano-convex to applanate, slightly hygrophanous; **MARGIN** inflexed, flat or waved, entire, undulate to lobed; **SURFACE** mat, tomentose, at the point of attachment villose, white, later whitish-greyish to pale beige; **LAMELLAE** $L = 10\text{--}28$, $l = 1\text{--}3$, ventricose, crowded to distant, adnexed, at first white, later pale beige to brownish, with pink tint; **EDGE** fimbriate and whitish; **STIPE** visible only in very young fruit-bodies.

MICROCHARACTERS — **BASIDIOSPORES** $(5.5\text{--})6.8\text{--}8.3\text{--}(10) \times (4.2\text{--})5\text{--}6\text{--}(7) \mu\text{m}$, $Q = (1.2\text{--})1.3\text{--}1.5\text{--}(1.6)$, broadly ellipsoid to ellipsoid, brownish-yellowish to yellowish in 5% KOH, in the LM echinulate, in the SEM distinctly echinulate with isolated spines; **SPINES** of 2 types: the larger ones up to $0.6 \mu\text{m}$ high, mostly conical attenuating to an obtuse apex and the smaller ones up to $0.4 \mu\text{m}$ high, conical to irregularly shaped, usually surrounding the larger ones (Figs 1, 4–6); **BASIDIA** $(21\text{--})22\text{--}27\text{--}(31) \times (6\text{--})6.8\text{--}8.4\text{--}(9) \mu\text{m}$, 4-spored, cylindrical, hyaline, thin-walled; **CHEILOCYSTIDIA** $(24\text{--})37.9\text{--}52\text{--}(64) \times (6\text{--})6.3\text{--}10.1\text{--}(17) \mu\text{m}$, narrowly utriform, clavate or cylindrical, in the upper part mostly branched, often antler-like, sometimes flexuous or angled, hyaline, thin-walled; **PILEIPELLIS** a transition between a cutis and a trichoderm, composed of cylindrical, hyaline, thin-walled, non-gelatinised and up to $6 \mu\text{m}$ thick hyphae without differentiated terminal cells, hyphae mostly straight; **CLAMP-CONNECTIONS** present in all tissues.

ECOLOGY — In general, three types of habitats can be recognized: 1) *Picea abies* forests; 2) spruce forests with admixed *Betula pubescens* and *Salix aurita* and

with *Sphagnum* sp. div. in the herb layer; 3) mixed forests formed by *Fagus sylvatica*, *Abies alba* and *Picea abies* with admixed *Acer pseudoplatanus* and *Ulmus* sp. The lowest collecting site is at 780 m a.s.l., the highest at 1445 m a.s.l. The species grows saprotrophically, producing fruitbodies on wood and bark of decaying trunks, branches, stumps, and roots of *Picea abies*; some branches were covered by lichenised fungi such as *Hypogymnia physodes* and *Lepraria* sp. From May to November.

SPECIMENS EXAMINED — *Crepidotus kubickae*: CZECH REPUBLIC. POŘÍČKO NAD SÁZAVOU, ad terram inter muscis, 29.V.1949, J. Kubička (PRM 665190; holotype). All following specimens from the PRM were collected in the “montes Šumava”, i.e. Šumava Mts., and were originally identified as *C. subsphaerosporus*: IN CLIVO MONTIS JEZERNÍ HORA SUPRA LACUM ČERTOVO JEZERO, OCC. LACU, alt 1200 m, Piceetum ad truncum deiectum Piceae, 29.IX.1994, J. Holec (PRM 885686). IN CLIVO SUPRA LACUM LAKA PR. PRÁŠILY, MER.-OCC. VERSUS LACUM, alt 1150 m, Piceetum humidum ad truncum emortuum Piceae, 30.IX.1994, J. Holec (PRM 885969). 1KM OR. VERSUS TURNEROVA CHATA PROPE SRNÍ, alt 950 m, silva mixta *Picea abies*, ad truncum iacentem, 25.VI.1996, J. Holec (PRM 888556). ČERNÉ JEZERO, SEPT. SUPRA LACUM, alt 1010 m, silva mixta *Picea abies*, ad truncum iacentem, 12.IX.1996, J. Holec (PRM 889444). TURFOSUM BLATENSKÁ SLAŤ, 2 KM OCC. VERSUS BŘEZNÍK, MER. VERSUS MODRAVA, alt 1250 m, ad trunc. emortuum Piceae, 17.IX.1996, J. Holec (PRM 889343). HORSKÁ KVILDA, INTER VYDŘÍ MOST ET RANKLOVSKÁ ROVINA, Sphagno-Piceetum, alt 1100 m, ad truncum iacentem Piceae, 19.IX.1996, J. Holec (PRM 889295). AREA DEFENSA JILMOVÁ SKÁLA SEPT. VERSUS ZÁTOŇ PROPE LENORA, alt 1000 m, *Picea abies*, ad truncum iac., 16.X.1996, Z. Pouzar (PRM 889541). IN VALLE RIVI HRÁDECKÝ POTOK, 1 KM MER.-OR.-OR. VERSUS SRNÍ, Piceetum + *Salix* etc., alt 780 m, *Picea abies*, ad truncum iacentem, 4.X.1997, J. Holec (PRM 898385). POVDŘÍ, LOCO “ČERNÉ STRÁNĚ” (AREA DEFENSA), 1 KM MER.-OR. VERSUS TURNEROVA CHATA APUD SRNÍ, silva montana mixta (*Fagus*, *Abies*, *Picea*), alt 940 m, in colle situ mer.-occ., *Picea abies*, ad truncum iacentem, 6.X.1997, J. Holec (PRM 898412). LOCO HUMIDO PROPE ZHŮŘÍ, MONS HUŤSKÁ HORA, 4 KM OR. VERSUS SRNÍ, *Sphagnum*, *Betula pubescens*, *Picea*, *Salix aurita*, alt 1010 m, in colle situ mer.-occ., *Picea abies*, ad truncum iacentem, 15.VI.1998, J. Holec (PRM 892380). TURFOSUM HŮRECKÉ SLATĚ, 0.6 KM SEPT. VERSUS NOVÁ HŮRKA PROPE Ž. RUDA, Sphagno-Piceetum, alt 880 m, *Picea abies*, ad truncum iacentem, 7.VII.1998, J. Holec (PRM 896948). MONS PLECHÝ, INTER PLECHÝ ET TROJMEZÍ, OCC. VERSUS NOVÁ PEC, silva virginea – Piceetum, alt 1340 m, in colle situ sept., *Picea abies*, ad codicem, 15.VII.1998, J. Holec (PRM 897059). LOCO DEBRNÍK, 1.7 KM MER. VERSUS ŽELEZNÁ RUDA, silva naturalis mixta (*Fagus*, *Picea*, *Abies*), alt 800 m, in colle situ mer.-occ., *Picea abies*, ad truncum iacentem., 21.IX.1998, J. Holec (PRM 897332). MONS RADVANOVICKÝ HŘBET, 2.7 KM SEPT.-OR. VERSUS ČESKÉ ŽLEBY, silva mixta (*Fagus*, *Picea*, *Acer pseudoplatanus*), alt 900 m, in colle situ mer.-or., *Picea abies*, ad truncum iacentem, 8.X.1998, J. Holec (PRM 897562). MONS RADVANOVICKÝ HŘBET, 2.9 KM SEPT.-OR. VERSUS ČESKÉ ŽLEBY, silva naturalis mixta (*Picea*, *Fagus*, *Abies*, *Ulmus* etc.), alt 900 m, in colle situ or., *Picea abies*, ad truncum iacentem, 8.X.1998, J. Holec (PRM 897575). TURFOSUM MEZILESNÍ SLAŤ (AREA DEFENSA), 3–4 KM SEPT.-SEPT.-OR. VERSUS KVILDA, IN VALLE RIVI HAMERSKÝ POTOK, Sphagno-Piceetum, alt 1090 m, *Picea abies*, ad truncum iacentem, 18.IX.1999, Z. Pouzar (PRM 898074). LOCO “STARÁ JÍMKA” PROPE PRÁŠILSKÉ JEZERO, 5.1 KM MER.-MER.-OR. VERSUS PRÁŠILY, Piceetum montanum, alt 1140 m, in colle situ sept., *Picea abies*, ad truncum iacentem, 10.X.2000, J. Holec (PRM 897882). AREA DEFENSA

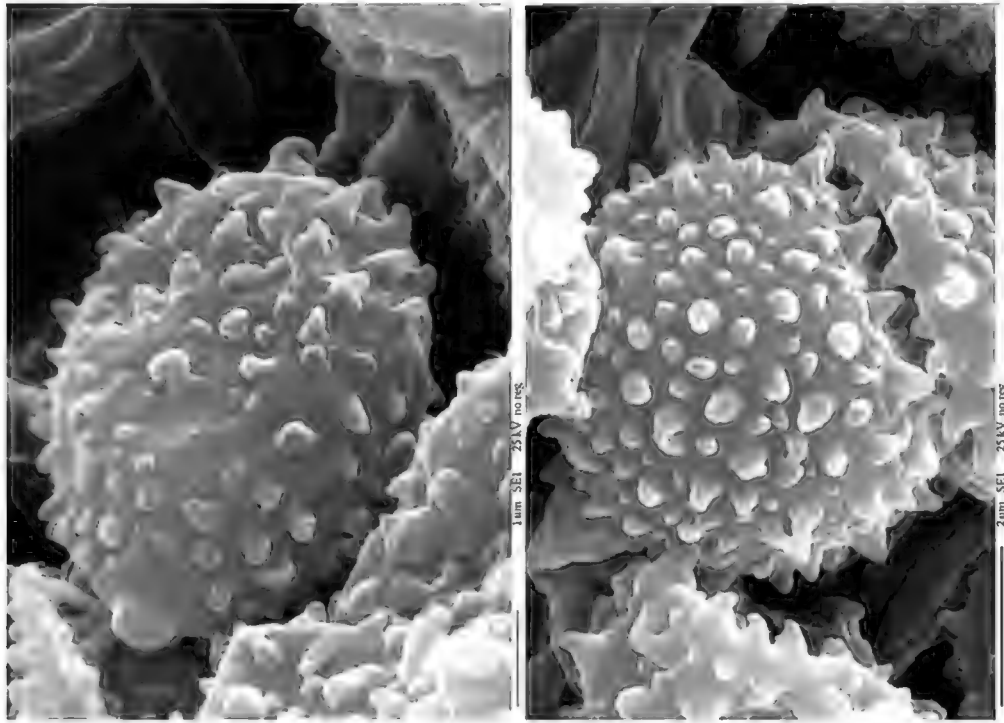


FIG. 1. *Crepidotus kubickae*: SEM photographs of spores (PRM 665190; holotype).

"BOUBÍNSKÝ PRALES" (PARS CENTRALIS), OCC. VERSUS KAPLICKÉ JEZÍRKO, CCA. 3.5 KM SEPT.-SEPT.-OR. VERSUS ZÁTOŇ APUD LENORA, silva virginea mixta (*Fagus*, *Abies*, *Picea*), alt 990 m, in colle situ or., *Picea abies*, ad truncum iacentem, 29.X.2002, J. Holec (PRM 900969). TURFOSUM "CIKÁNSKÁ SLAŤ" (AREA DEFENSA), PARS. SEPT.-OCC., 3 KM MER.-OCC. VERSUS MODRAVA, Piceetum humidum + Sphagno-Piceetum, alt 1090 m, *Picea abies*, ad codicem, 8.VI.2004, J. Holec (PRM 901812). POLAND. WESTERN TATRA MTS. (514.52), SARNIA SKAŁA MASSIF, LOWER PART OF DOLINA SPADOWIEC VALLEY, NEAR DROGA POD REGLAMI HIKING TRAIL, 49°16'43"N, 19°57'7"E, ?*Abieti-Piceetum montanum*, alt 930 m, on trunk of *Picea abies*, 8.XI.2000, A. Ronikier (KRAM 50390 as *C. cesatii* var. *subsphaerosporus*). WESTERN TATRA MTS. (514.52), SARNIA SKAŁA MASSIF, SPALENIEC RIDGE (BETWEEN DOLINA KU DZIURZE VALLEY AND DOLINA SPADOWIEC VALLEY), 49°16'20"N, 19°56'52"E, *Dentario glandulosae-Fagetum*, alt 1150 m, on wood and bark of *Picea abies*, 15.VI.2001, A. Ronikier (KRAM 53294 as *C. cesatii* var. *subsphaerosporus*). WESTERN TATRA MTS. (514.52), SARNIA SKAŁA MASSIF, LOWER PART OF DOLINA KU DZIURZE VALLEY, 49°16'43"N, 19°56'37"E, *Dentario glandulosae-Fagetum*, alt 920 m, on wood, stump and roots of *Picea abies*, 6.VII.2001, A. Ronikier (KRAM 53295 as *C. cesatii* var. *subsphaerosporus*). HIGH TATRA MTS. (514.53), DOLINA PAŃSZCZYCA VALLEY, LOWER PART OF THE VALLEY, ABOUT 100 M W FROM POLANA WAKSMUNDZKA MEADOW, 49°16'4"N, 20°3'34"E, *Piceetum tatricum*, alt 1400 m, on wood of *Picea abies*, 19.VII.2000, A. Ronikier (KRAM 50110 as *C. cesatii* var. *subsphaerosporus*). TATRZAŃSKI PARK NARODOWY, DOLINA SUCHEJ WODY, PONIŻEJ UJŚCIA ŻÓŁTEGO POTOKU DO SUCHEJ WODY. *Piceetum tatricum myrtilletosm*, alt 1360 m, na kłodzie *Picea excelsa*, 15.VIII.1973, Z. Heinrich (KRAM 30284 as *C. subsphaerosporus*). TATRY, TATRZAŃSKI PARK NARODOWY, DOLINA RYBIEGO POTOKU, alt 1350 m, 2.VI.1972, Z. Heinrich (KRAM 56059 not identified before). TATRY, DOLINA BIAŁKI, MIĘDZY SCRONISKIEM W ROZTOCE A NIŻNĄ POLANĄ POD WOŁOSZYNYM, alt 1020 m, na leżącym pniu *Picea*, 6.VI.1983, H. Komorowska (KRAM 56048 not identified before). SLOVAKIA. VEPORSKÉ VRCHY Mts., POLOMKA, THE NATURE RESERVE OF FABOVA HOĽA, NNW OF THE BENCH MARK FABOVA HOĽA (1438.8), spruce forest, alt



FIG. 2. *Crepidotus cesatii*: SEM photographs of spores (SLO 610).

1400 m, on wood of fallen trunk of *Picea abies*, 7.X.2002, I. Mihál and D. Blanár (SLO 701). VEPORSKÉ VRCHY Mts., POHRONSKÁ POLHORA, THE NR OF FABOVA HOĽA, NNW OF THE BENCH MARK FABOVA HOĽA (1438.8), spruce forest, alt 1435–1445 m, on bark of fallen trunk of *Picea abies*, 25.XI.2008, D. Blanár (SLO 702). STOLICKÉ VRCHY Mts., KROKAVA, THE NR OF TRSTIE, SEE OF THE BENCH MARK HOLCKOVÁ (1101.8), spruce forest, alt 1100 m, on bark of fallen trunk of *Picea abies*, 16.X.2008, D. Blanár (SLO 703). SWITZERLAND. BERN, RÖTHENBACH, SCHINEGGSCHWAND AM SCHALLBERG, alt 1000 m, Reisighaufen (*Picea*), Abieti-Fagetum, 11.X.1989, B. Senn-Irlet [G 89/240 as *C. cesatii* var. *subspheerosporus*; neotype].

***Crepidotus cesatii*:** SLOVAKIA. ZÁHORSKÁ NÍŽINA LOWLAND, MORAVSKÝ SVÄTÝ JÁN, CA. 4.5 KM WESTWARD OF THE CHURCH OF ST. JÁN KRSTITEĽ, flood plain forest *Salicion albae*, alt 153 m, on bark of fallen decaying branch of *Salix alba*, 24.VII.2001, S. Ripková (SLO 601). PODUNAJSKÁ NÍŽINA LOWLAND, BRATISLAVA, THE MUNICIPAL PART OF DEVÍN, SEDLÁČKOV OSTROV ISLAND, flood plain forest, alt 135 m, on bark of decaying branch of standing *Acer campestre*, 2.IX.1998, S. Ripková (SLO 602). BIELE KARPATY Mts., NOVÁ BOŠÁCA, THE SETTLEMENT OF GRŮŇ, LOCALITY KORYTO, BANK OF THE PREDPOLOMSKÝ POTOK STREAM, forest occupied by *Alnus glutinosa* and *Salix* sp. div., alt 338 m, on wood and bark of fallen decaying branch of deciduous tree, 9.VII.2002, S. Ripková (SLO 603). MALÉ KARPATY Mts., KUCHYŇA, ALONG THE BLUE MARKED TRAIL CA. 2.5 KM NE OF THE CHURCH IN THE VILLAGE, forest occupied by *Fagus sylvatica*, *Carpinus betulus*, *Quercus* sp., alt 340 m, on wood and bark of fallen decaying branch of deciduous tree, 13.X.2007, S. Ripková (SLO 604). STOLICKÉ VRCHY Mts., TISOVEC, THE PROTECTED SITE OF VACHTOVÉ JAZIERKO, line vegetation dominated by *Salix* sp. div., alt 395 m, on wood and bark of decaying branch of standing *Salix caprea*, 7.II.2002, D. Blanár (SLO 605). STOLICKÉ VRCHY Mts., MURÁNSKA DLHÁ LÚKA, THE ČERVENÁ VALLEY, forest occupied by *Corylus avellana*, *Carpinus betulus* etc., alt 370 m, on wood of fallen branch of *Carpinus betulus*, 31.X.2001, D. Blanár (SLO 606). REVÚCKA VRCHOVINA, RATKOVÁ, wetland Typhetum latifoliae, alt 285 m, on wood of fallen decaying branch of *Salix fragilis*, 12.XI.2001, D. Blanár (SLO 607). SLOVENSKÝ KRAS



FIGS 3–4. LM photographs of spores.

FIG. 3 (top). *Crepidotus cesatii* (SLO 610). FIG. 4 (bottom). *Crepidotus kubickae* (SLO 703).

MTS., JELŠAVA, LOCALITY SKALKA, deciduous forest, NE exp., alt 320–360 m, on bark of branch of standing *Cornus mas*, 22.I.2002, D. Blanár (SLO 608). MURÁNSKA PLANINA MTS., MURÁŇ, THE NATIONAL NATURE RESERVE OF ŠARKANICA, THE MARTINOVA VALLEY, forest dominated by *Fagus sylvatica*, alt 560 m, on bark of fallen decaying branch of *Fagus sylvatica*, 31.VII.2002, D. Blanár (SLO 609). VIHORLATSKÉ VRCHY MTS., THE



FIGS 5–6. LM photographs of spores.

FIG. 5 (top). *Crepidotus kubickae* (PRM 665190; holotype).

FIG. 6 (bottom). *Crepidotus cesatii* var. *subsphaerosporus* (G 89/240; neotype).

VALLEY OF THE DIELOVÝ POTOK STREAM, CA. 3 KM SW OF THE CHURCH IN THE VILLAGE OF PODHOROŽ, forest dominated by *Carpinus betulus* and *Quercus petraea*, alt 250 m, on wood and bark of fallen decaying branch of deciduous tree, 19.X.2002, S. Ripková (SLO 610).

COMMENTS — *Crepidotus variabilis* var. *subsphaerosporus* was validly published by Lange (1940). Kühner & Romagnesi (1953) and Hesler & Smith (1965) raised this variety to the specific rank as *C. subsphaerosporus*, but the name was not validly published in either work. Kühner & Romagnesi (1953) placed “*C. subsphaerosporus*” close to *C. cesatii* in their key. Although Hesler & Smith (1965) separated “*C. subsphaerosporus*” from *C. variabilis* (Pers.) P. Kumm. based on distinct spore characters, they did not question the relationship between the two taxa.

Three years after she had studied types of Pilát’s *Crepidotus* species, including *C. kubickae* (Senn-Irlet 1992), Senn-Irlet (1995) used the name *C. variabilis* var. *subsphaerosporus* as a basionym for her new combination, *C. cesatii* var. *subsphaerosporus*. Although Senn-Irlet (1992) emphasized distinct differences in characters of spores of *C. kubickae* (shape, coloration and ornamentation), she concluded that the species is best interpreted as a variant of *C. cesatii*. Subsequently, she merged the name *C. kubickae* into the synonymy of *C. cesatii* var. *subsphaerosporus* (Senn-Irlet 1995).

I think that *C. kubickae* is related to *C. cesatii*. Both species have similar basidia (4-spored, cylindrical, hyaline, thin-walled) and cheilocystidia (narrowly utriform, clavate or cylindrical, in the upper part mostly branched, often antler-like, sometimes flexuous or angled, hyaline, thin-walled); for size of these structures see TABLE 1. Some differences can be found in the pileipellis, hyphae of which are mostly straight in *C. kubickae* and mostly coiled in *C. cesatii*. However, the decisive differences are in spore characters, namely in the shape and ornamentation. The spores of *C. kubickae* are broadly ellipsoid to ellipsoid, with the ratio of length and width (1.2–)1.3–1.5(–1.6); they are echinulate in the LM, after focusing carefully, and distinctly so in the SEM; they are covered by 2 types of isolated spines: the larger ones up to 0.6 µm high, mostly conical attenuating to an obtuse apex and the smaller ones up to 0.4 µm high, conical to irregularly shaped, usually surrounding the larger ones (FIG. 1). The spores of *C. cesatii* are subglobose, broadly ellipsoid to ellipsoid, with the ratio of length and width (1–)1.2–1.4(–1.45); they seem to be punctate to finely echinulate in the LM, but they are verrucose in the SEM, covered by isolated, rather elongated verrucas, sometimes slightly broadened at base, up to 0.4 µm high (FIG. 2). Observing the spores macerated in the 5% KOH solution in the LM, the differences are also in their colour: the spores of *C. kubickae* are brownish-yellowish to yellowish and the spores of *C. cesatii* are yellowish to hyaline. Ecological differences are also important. While *C. kubickae* prefers coniferous trees such as *Picea*, *Abies*, and *Pinus*, *C. cesatii* prefers hardwood, e.g. *Acer*, *Alnus*, *Cornus*, *Corylus*, *Fagus*, *Fraxinus*, *Salix*, *Tilia* (“Specimens examined”, Senn-Irlet 1995, Ripková & Blanár 2004, Pouzar 2005).

TABLE 1. Comparison of microcharacters between *Crepidotus kubickae* and *C. cesatii*

	<i>Crepidotus kubickae</i>	<i>Crepidotus cesatii</i>
BASIDIOSPORES		
SIZE	(5.5–)6.8–8.3(–10) × (4.2–)5–6(–7) µm	(5.5–)6.8–8.1(–9) × (5.2–)5.5–6.4(–7) µm
Q	(1.2–)1.3–1.5(–1.6)	(1–)1.2–1.4(–1.45)
SHAPE	broadly ellipsoid to ellipsoid	subglobose, broadly ellipsoid to ellipsoid
COLOUR IN KOH SOLUTION	brownish-yellowish to yellowish	yellowish to hyaline
SURFACE (SEEN IN LM)	echinulate	punctate to finely echinulate
SURFACE (SEEN IN SEM)	echinulate, covered by 2 types of isolated spines: one type ≤ 0.6 µm high, mostly conical narrowing to an obtuse apex; the second type smaller, ≤ 0.4 µm high, conical to irregularly shaped	verrucose, covered by only 1 type of isolated, rather elongated verrucas, bases sometimes slightly broadened, ≤ 0.4 µm high
BASIDIA	(21–)22–27(–31) × (6–)6.8–8.4(–9) µm	(26–)27–33(–36) × (7–)7.8–9 µm
CHEILOCYSTIDIA	(24–)37.9–52(–64) × (6–)6.3–10.1(–17) µm	(24–)32.8–47.1(–49) × (–4.5)4.9–9.3(–13) µm
PILEIPELLIS HYPHAE	mostly straight	mostly coiled

As the spores of *C. kubickae* are so distinct and unique within the genus, I consider the species delimitation based on the spore characters sufficient and well established. In conclusion, *C. kubickae* is the oldest legitimate name at species rank for the fungus, and I suggest using it as the correct name. After having compared the type material of *C. kubickae* and *C. cesatii* var. *subsphaerosporus*, I have not found any differences between them (FIGS 5, 6). I consider *C. cesatii* var. *subsphaerosporus* identical with *C. kubickae* and I merge it into the synonymy of *C. kubickae*.

Crepidotus subepibryus is another probably closely related taxon. Senn-Irlet (1993) mentioned that the ultrastructure of the spore ornamentation of *C. subepibryus* indicated a close relationship with *C. cesatii*, probably with *C. cesatii* var. *subsphaerosporus*, and she interpreted it as an abnormality of *C. cesatii*. Later, she included *C. subepibryus* into the synonymy of *C. cesatii* var. *subsphaerosporus* (Senn-Irlet 1995). Horak (2005) identified *C. subepibryus* with *C. kubickae* and proposed the former as the correct name. Pouzar (2005) treated *C. subepibryus* as a distinct species. He did not identify it with *C. cesatii* var. *subsphaerosporus*, because the spores of *C. subepibryus* are narrower and distinctly tapered towards the apiculus (Pouzar 2005). I consider the fungus unidentifiable at present because only two specimens of *C. subepibryus* (both from the type locality) are hitherto known.

Acknowledgments

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Literature cited

- Comesaña P, Castro ML. 2000. Fragmenta chorologica occidentalia, Fungi 7460–7497. *Anales Jard. Bot. Madrid* 58: 170–172.
- Gerault A. 2005. Florule évolutive des *Basidiomycotina* du Finistère. *Homobasidiomycetes, Cortinariales*, Version 2.0. [<http://projet.aulnaies.free.fr/Florules/CORTINARIALES.pdf> (viewed online on 1 April 2009)].
- Gonou-Zagou Z, Delivorias P. 2005. Studies on *Basidiomycetes* in Greece 1: The genus *Crepidotus*. *Mycotaxon* 94: 15–42.
- Hesler LR, Smith AH. 1965. North American Species of *Crepidotus*. Hafner Publishing Company, New York, London.
- Horak E. 2005. Röhrlinge und Blätterpilze in Europa. Elsevier GmbH, Spektrum Akademischer Verlag, Heidelberg.
- Kühner R, Romagnesi H. 1953. Flore Analytique des Champignons Supérieurs (Agarics, Bolets, Chanterelles). 1st ed. Masson et Cie, Paris.
- Lange JE. 1938. Studies in the Agarics of Denmark. XII. *Dansk Bot. Ark.* 9(6): 1–104.
- Lange JE. 1939. Fl. Agaric. Danic. Vol. 4. The Society for the Advancement of Mycology in Denmark, the Danish Botanical Society, Copenhagen.
- Lange JE. 1940. Fl. Agaric. Danic. Vol. 5. The Society for the Advancement of Mycology in Denmark, the Danish Botanical Society, Copenhagen.
- Pilát A. 1949. Ad Monographiam *Crepidotorum* Europaeorum Supplementum I. *Stud. Bot. Čechoslov.* 10: 149–154.
- Pouzar Z. 2005. Klíč na určování našich trepkovitek (*Crepidotus*) a poznámky k nim. (A key to our species of the genus *Crepidotus* and notes to them.) *Mykol. Listy* 93: 1–9.
- Ripková S, Blanár D. 2004. Výskyt druhov rodu *Crepidotus* na Muránskej planine a v priľahlej oblasti Slovenského rudohoria. (The occurrence of the species of the genus *Crepidotus* in the Mauránka planina Mts., and in the adjacent area of the Slovenské Rudohorie Mts.) *Reussia* 1, Supplement 1 : 49–67.
- Roux P. 2006. Mille et un champignons. Édition Roux, Sainte-Sigolène.
- Senn-Irlet B. 1992. Type studies in *Crepidotus* – I. *Persoonia* 14: 615–623.
- Senn-Irlet B. 1993. Type studies in *Crepidotus* – II. *Persoonia* 15: 155–167.

- Senn-Irlet B. 1995. The genus *Crepidotus* (Fr.) Staude in Europe. *Persoonia* 16: 1–80.
- Vellinga EC. 1988. Glossary. 54–64, in: C Bas et al. (eds.), *Flora Agaricina Neerlandica* Vol. 1., AA. Balkema, Rotterdam.
- Walley R, Vandeveer E (eds). 2006. Standaardlijst van *Basidiomycota* en *Myxomycota* van Vlaanderen en het Brussels Gewest. Instituut voor Natuur- en Bosonderzoek, Brussel. [<http://www.inbo.be/docupload/3062.pdf> (viewed online on 1 April 2009)].

***Crepidotus subfulviceps* comb. nov., a stipitate *Crepidotus* from temperate North America and Europe**

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Abstract — Nuclear rDNA sequence analyses indicate that *Tubaria decurrens*, a Pan-American species recently discovered in Spain, belongs in the genus *Crepidotus*. This is the fourth reported centrally stipitate species in the otherwise predominantly pleurotoid genus *Crepidotus*. The new combination *Crepidotus subfulviceps* is proposed.

Key words — Agaricales, Crepidotaceae, fungal systematics, *Melanomphalia*

Introduction

The *Crepidotaceae* (*Basidiomycota*, *Agaricales*) s. Singer (1986) contains several genera of centrally stipitate mushrooms that have since been excluded from the family based on nuclear rDNA sequence analyses and type studies (Aime et al. 2005). However, it was concluded that while the type species of *Tubaria* (W.G. Sm.) Gillet and *Melanomphalia* M.P. Christ. did not belong in *Crepidotaceae*, several other taxa currently allied within those genera might be more closely related to *Crepidotus* than to the types of the former two genera, warranting further study (Aime et al. 2005). The genus *Tubaria* has since been shown to be polyphyletic (Matheny et al. 2007) and at least one species of *Melanomphalia* has been transferred to *Crepidotus* based on rDNA analyses (Aime et al. 2002).

Recently Vila et al. (2007) found several collections of a centrally stipitate mushroom in Spain that was found to be conspecific with *Tubaria decurrens*, a Pan-American species originally described from Kansas. The taxon was completely described and illustrated and the authors speculated on the relationship between *T. decurrens* and members of the *Crepidotaceae*. Subsequent phylogenetic analyses of the nuclear large subunit rDNA region

confirms that this taxon is, in fact, a *Crepidotus* species and the new combination *C. subfulviceps* is proposed to accommodate it.

Materials and methods

A total of 19 species were chosen for analysis. Exemplar taxa, including type species from *Crepidotus* [type, *C. mollis* (Schaeff.) Staude 1857], *Tubaria* [type, *T. furfuracea* (Pers.) Gillet 1876], and *Melanomphalia* [type, *M. nigrescens* M.P. Christ. 1936], were selected from previously published *Crepidotaceae* nuclear large subunit rDNA (LSU) datasets (Moncalvo et al. 2000, 2002; Aime et al. 2002, 2005; Aime & Miller 2002) and from the genus *Inocybe*, which has been suggested as the sister group to the *Crepidotaceae* s.s. (Matheny et al. 2006). DNA was extracted from dried tissue from two herbarium specimens of *Tubaria decurrens*, placed in 2 mL Bead Solution tubes of the UltraClean Plant DNA Isolation Kit, and extracted per the manufacturer's instructions (MoBio Laboratories, Inc., Solana Beach, CA). The first 1250 bp of the LSU were amplified and sequenced with primers LSU4-B (Aime & Phillips-Mora 2005) and LR6 (Moncalvo et al. 1995) and sequenced as previously described in Aime & Phillips-Mora (2005). Specimen vouchers are deposited in Herbarium BCN (Centre de Documentació de Biodiversitat Vegetal, Universitat de Barcelona); sequence vouchers are deposited in GenBank (<http://www.ncbi.nlm.nih.gov/>).

For phylogenetic analyses, sequences were edited and contiguous sequences were assembled in Sequencher v.4.1.4 (Gene Codes Corp., Ann Arbor, MI). Sequence alignments were constructed by eye in Se-Al v2.0a11 (Andrew Rambaut, Dept. Zoology, University of Oxford, U.K.; <http://evolve.zoo.ox.ac.uk/>). Regions too variable to confidently align (a total of 27 bp in a single indel region) were excluded from the final analyses. Maximum parsimony (MP) analyses were conducted in PAUP* v4.0b10 (Swofford 2002) as heuristic searches with 100 random addition replicates and TBR branch swapping. Support for the branching topologies was evaluated by bootstrap analysis derived from 1000 replicates with 10 random addition replicates each.

Taxonomy

***Crepidotus subfulviceps* (Murrill) Aime, Vila & P.-A. Moreau, comb. nov.**

MYCOBANK MB513297

BASIONYM: *Omphalina subfulviceps* Murrill, Lloydia 7(4): 309 (1945, "1944").

= *Flammula decurrens* Peck, Bull. Torrey Bot. Club 22(12): 489 (1895).

= *Tubaria decurrens* (Peck) Murrill, North American Flora 10(2): 159 (1917).

?= *Tubaria omphaliopsis* Singer, in Singer & Digilio, Lilloa 25: 397 (1952, "1951").

= *Melanomphalia omphaliopsis* (Singer) Singer, in Petersen, Evolution in the higher Basidiomycetes: 459 (1971).

MATERIAL STUDIED: SPAIN. CATALONIA: Girona, Palafrugell, 30 Sep 2003, C. Roqué (BCN SCM B-5138), GenBank FJ947117; Prés de la Punta de la Creueta, Tarragona, 18 Oct 2005, J. Vila, X. Llimona, and L. Balcells (BCN SCM B-5144), GenBank FJ947116.

COMMENTS: *Crepidotus* is a genus with over 250 described species of saprotrophic pleurotoid agarics (Hesler & Smith 1965). Sequence analyses from the nuclear LSU rDNA region confirm the placement of *T. decurrens* within the

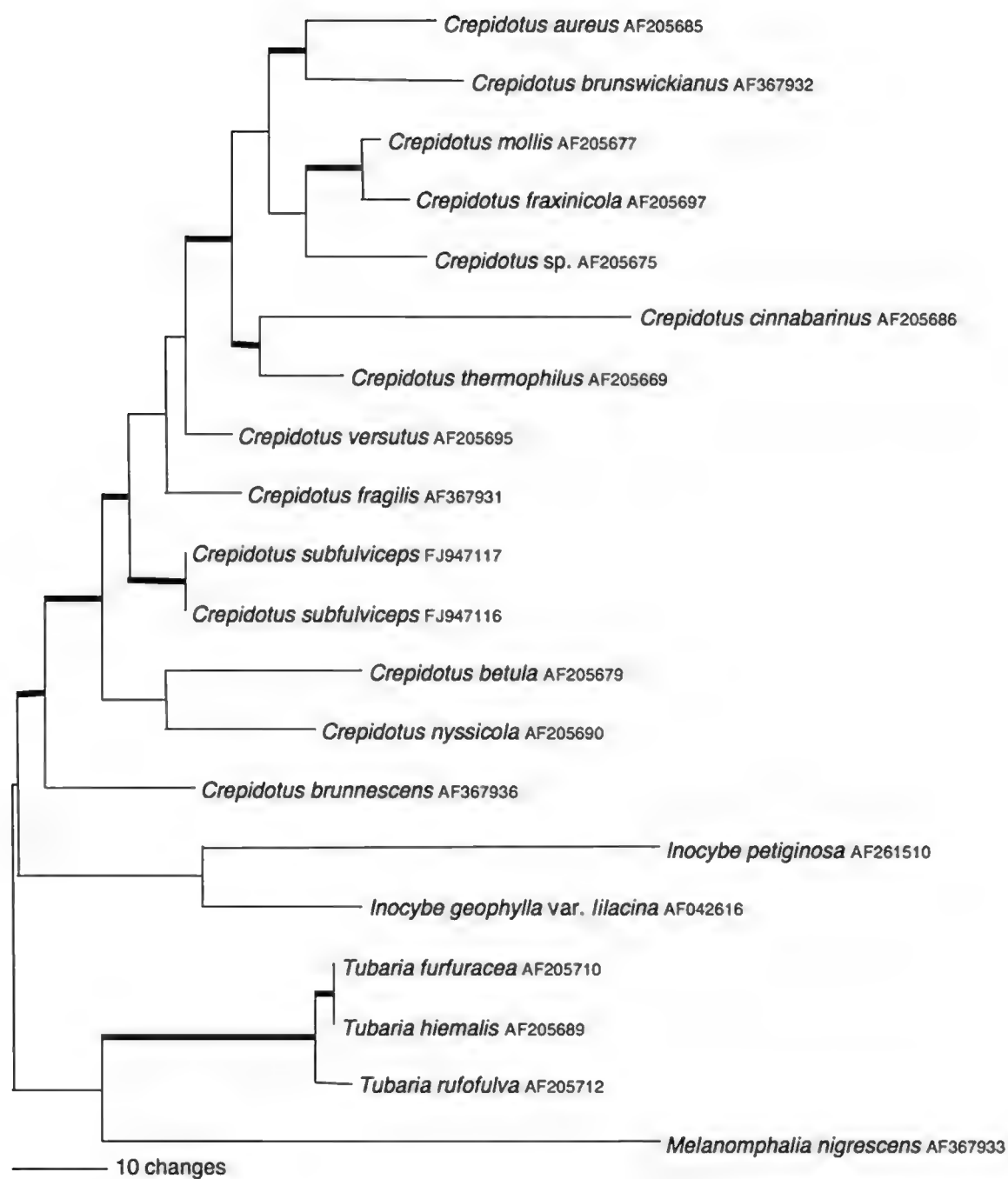


FIGURE 1. Mid-point rooted phylogenetic tree from MP analyses of nuclear large subunit ribosomal DNA showing position of *C. subfulviceps* within *Crepidotus*. Thickened branches are those receiving significant (>75% bootstrapping) support.

genus *Crepidotus* (FIG. 1). The internal transcribed spacer region of the nuclear rDNA was also sequenced and analyzed with the same result (data not shown). Thus, the placement of *T. decurrens* within *Crepidotus* marks the fourth stipitate species of *Crepidotus* within this otherwise pleurotoid genus (Hesler & Smith 1965, Aime et al. 2002).

Phylogenetic analyses show that three of the known species of stipitate *Crepidotus*—*C. nyssicola* (Murrill) Singer 1973, *C. thermophilus* (Singer) Aime et al. 2002, and *C. subfulviceps*—do not form a monophyletic group (FIG. 1)

and therefore represent independent reversions to the stipitate habit within this genus. *Crepidotus subfulviceps* can be easily distinguished from the other known stipitate species of *Crepidotus* by its basidiospores, which are small (avg. 5 µm diam), globose and strongly echinulate in *C. nyssicola* versus amygdaliform in *C. subfulviceps*, and shorter (7.0–10.7 µm) with verrucose ornamentation in *C. thermophilus* versus 9.5–10.8 µm and faintly rugose in *C. subfulviceps*. A fourth species, *Crepidotus ibericus* (G. Moreno & Esteve-Rav.) Bandala et al. 2008 has recently been transferred to *Crepidotus* (Bandala et al. 2008) and differs from the other known stipitate species in having smooth basidiospores.

The combination *Crepidotus decurrens* is not available for this taxon. *Crepidotus decurrens* States (States 1973) is a synonym for the North American *C. cinnabarinus* Peck 1895 (Luther & Redhead 1981), an astipitate temperate species distinguished by its scarlet-red pileus and gills that has no relation to *T. decurrens*. Thus, *C. subfulviceps* becomes the oldest available name that can be unambiguously assigned to this taxon. *Crepidotus subfulviceps* has been completely described and illustrated in Vila et al. 2007.

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Literature cited

- Aime MC, Baroni TJ, Miller OK. 2002. *Crepidotus thermophilus* comb nov., a reassessment of *Melanomphalia thermophila*, a rarely collected tropical agaric. *Mycologia* 94: 1059–1065.
- Aime MC, Miller OK. 2002. Delayed germination of basidiospores in temperate species of *Crepidotus* (Fr.) Staude. *Canadian Journal of Botany* 80: 280–287.
- Aime MC, Phillips-Mora W. 2005. The causal agents of witches' broom and frosty pod rot of cacao (chocolate, *Theobroma cacao*) form a new lineage of *Marasmiaceae*. *Mycologia* 97(5): 1012–1022.
- Aime MC, Vilgalys R, Miller OK. 2005. The *Crepidotaceae* (*Basidiomycota*, *Agaricales*): Phylogeny and taxonomy of the genera and revision of the family based on molecular evidence. *American Journal of Botany* 92: 74–82.
- Bandala VM, Esteve-Raventós F, Montoya L. 2008. Two remarkable brown-spored agarics from Spain: *Simocybe parvispora* sp. nov. and *Crepidotus ibericus* comb. nov. *Sydowia* 60:181–196.
- Hesler LR, Smith AH. 1965. North American Species of *Crepidotus*. Hafner Publishing Company, New York, New York, USA.
- Luther BS, Redhead SA. 1981. *Crepidotus cinnabarinus* in North America. *Mycotaxon* 12: 417–430.
- Matheny PB, Curtis JM, Hofstetter V, Aime MC, Moncalvo JM, Ge ZW, Yang ZL, Slot JC, Ammirati JF, Baroni TJ, Bougher NL, Hughes KW, Lodge DJ, Kerrigan RW, Seidl MT, Aanen DK, DeNitis M, Daniele GM, Desjardin DE, Kropp BR, Norvell LL, Parker A, Vellinga EC, Vilgalys R, Hibbett DS. 2006. Major clades of *Agaricales*: a multilocus phylogenetic overview. *Mycologia* 98 (6): 982–995.

- Matheny PB, Vellinga EC, Bougher NL, Ceska O, Moreau PA, Neves MA, Ammirati JF. 2007. Taxonomy of displaced species of *Tubaria*. *Mycologia* 99: 569–585.
- Moncalvo JM, Lutzoni F, Rehner SA, Johnson J, Vilgalys R. 2000. Phylogenetic relationships of agaric fungi based on nuclear large subunit ribosomal DNA sequences. *Systematic Biology* 49: 278–305.
- Moncalvo JM, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Cléménçon H, Miller OK. 2002. One hundred and seventeen clades of euagarics. *Molecular Phylogenetics and Evolution* 23: 357–400.
- Moncalvo JM, Wang HH, Hseu RS. 1995. Phylogenetic relationships in *Ganoderma* inferred from the internal transcribed spacers and 25S ribosomal DNA sequences. *Mycologia* 87: 223–238.
- Peck CH. 1895. New species of fungi. *Bulletin of the Torrey Botanical Club* 22: 485–493.
- Singer R. 1986. The *Agaricales* in modern taxonomy, 4th ed. Koeltz Scientific Books, Koenigstein, Germany.
- States J. 1973 (“1972”). A new red-colored species of *Crepidotus*. *Bulletin of the Torrey Botanical Club* 99: 250–251.
- Swofford DL. 2002. PAUP*: Phylogenetic analysis using parsimony (*and other methods), version 4. Sinauer, Sunderland, MA.
- Vila J., Moreau P-A, Tabarés M, Carbó J, Pérez-de-Gregorio MA. 2007. *Tubaria decurrens*, une espèce américaine redécouverte en Europe (*Tubaria decurrens*, a American species found in Europe). *Cryptogamie Mycologie* 28: 1–11.

Taxonomic studies on *Ustilaginomycetes* – 29

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Abstract — New species described: *Antherospora eucomis*, *Entyloma eryngii-alpini*, *Farysia globispora*, *F. longispora*, *F. microspora*, *Macalpinomyces loudetiopsisidis*, *Moreaua capillaceae*, *Mo. eximiae*, *Mo. peckii*, *Mo. tothii*, *Sporisorium schizachyrii-sanguinei*, *Urocystis pulsatillae-albae*, *Ur. vulpiae*, *Ustilago piptatheri*. New name: *Sporisorium sydowiorum*. New combinations: *Heterodoassansia downingiae*, *Microbotryum moelleri*, *Tolyposporium solidum*. Excluded from the smut fungi are: *Entyloma cyperi* and *Ustilago dactylicola*. Keys are given to the species of *Antherospora*, *Entyloma* on *Eryngium*, *Moreaua* on *Schoenus* and *Tetraria*, *Sporisorium* on *Setaria* and *Schizachyrium sanguineum*, *Urocystis* on *Ranunculus* and *Pulsatilla*, and to smut fungi of *Loudetia*, *Loudetiopsis*, *Trichopteryx*, *Tristachya*, and *Zonotriche*.

Key words — *Anthracoideaceae*, *Floromycetaceae*, taxonomy

New species

Three new *Farysia* species from Australasia

The genus *Farysia* Racib. is characterised by sori produced in single flowers of *Cyperaceae* (*Carex*, *Uncinia*); the spore masses are traversed by numerous, conspicuous, capillitium-like fascicles of sterile hyphae. The spores, which are produced in chains by division of the sporogenous hyphae, are single, while sterile cells are absent. About 17 species are recognised. Species delimitation, based on spore morphology, is difficult because of variability in shape and size of spores within a sorus. A critical revision of the genus, with modern molecular methods, is badly needed. However, a comparison of the type specimens shows more or less marked differences. Some collections of *Farysia* on *Carex* species from Australia and New Zealand differ from earlier known species and are described as new.

Farysia globispora Vánky & R.G. Shivas, sp. nov.

MYCOBANK MB 513203

Typus in matrice *Carex appressa*, Australia, New South Wales, cca. 6 km SE oppid. Woodenbong, North Yabba Road, 28°25' S, 152°39' E, 29.XII.1981, leg. K.L. Wilson 4144.
Holotypus HUV 19507! (ex NSW); *isotypus* DAR 75353.

Sori in nonnullis floribus inflorescentiae, primum in utriculis formati, deinde prorumpentes, globoidei, diametro 1.5–2 mm, massa sporarum atro-olivaceobrunnea, primum agglutinata deinde pulverea, cum fasciculis tenuibus filamentorum steriliū fungalium mixta. Sporae globosae, subglobosae, raro late ellipsoidales, (5–)5.5–9.5 × (5–)5.5–11(–12) μm, pallide olivaceobrunneae; pariete aequaliter 1–2 μm crasso, verrucoso, verrucis interdum in seriebus ordinatis, imago obliqua sporarum sinuata usque leniter serrulata.

SORI (FIG. 1) in some flowers of an inflorescence, formed within the utricles, later bursting, globoid, 1.5–2 mm in diam., spore mass dark olivaceous brown, first agglutinated later powdery, mixed with thin fascicles of sterile fungal filaments. SPORES (FIGS. 4, 5) globose, subglobose, rarely broadly ellipsoidal, (5–)5.5–9.5 × (5–)5.5–11(–12) μm, pale olivaceous brown; wall evenly 1–2 μm thick, verrucose, warts sometimes arranged in rows, spore profile wavy to finely serrulate.



FIG. 1. Sori of *Farysia globispora* in some flowers (utricles) of *Carex appressa* (type).

FIG. 2. Sori of *Farysia longispora* (type) in some flowers of *Carex dipsacea*.

Bars = 1 cm for habit; 1 mm for detail.

On *Cyperaceae*: *Carex*, subgen. *Vignea*, sect. *Paniculatae*, *C. appressa* R. Br.; Australia. Known only from the type collection.

Typical for *Farysia globispora* are the relatively uniform, mostly globose spores.

***Farysia longispora* Vánky & McKenzie, sp. nov.**

MYCOBANK MB 513204

TYPUS in matrice *Carex dipsacea*, New Zealand, North Island, Auckland, Helensville, I.1924, leg. E.H. Atkinson. *Holotypus* PDD 1283, *isotypus* HUV 18754!

Sori in nonnullis floribus inflorescentiae, cylindracei, cca. 1.5 × 2.5–3 mm, peridio tenello, cinereo cooperti, quo rupto irregulariter massam sporarum atro-olivaceobrunneam, semiagglutinatam usque pulveream cum fasciculis longis filamentorum funga lium sterilium mixtam ostendentes. Sporae breviter usque longe ellipsoidales, elongatae, raro subglobosae, ovoideae vel parum flexae, “bouverang-formes”, 4–5(–5.5) × 4.5–13(–16) μm, pallide olivaceobrunneae; pariete aequaliter cca. 0.5 μm crasso, dense, irregulariter verrucoso, imago obliqua sporarum leniter sinuata.

SORI (FIG. 2) in some flowers of an inflorescence, cylindrical, c. 1.5 × 2.5–3 mm., first covered by a thin, grey peridium which ruptures irregularly disclosing the dark olivaceous brown, semiagglutinated to powdery mass of spores mixed with long fascicles of sterile fungal filaments. SPORES (FIGS. 6, 7) short to long ellipsoidal, elongated, rarely subglobose, ovoid or slightly bent, boomerang-shaped, 4–5(–5.5) × 4.5–13(–16) μm, pale olivaceous brown; wall evenly c. 0.5 μm thick, densely, irregularly verrucose, spore profile finely wavy.

On *Cyperaceae*: *Carex*, subgen. *Carex*, sect. *Echinolaenae*, *C. dipsacea* Berggr.; New Zealand. Known only from the type collection.

Typical for *Farysia longispora* is the high percentage of elongated spores.

***Farysia microspora* Vánky & McKenzie, sp. nov.**

MYCOBANK MB 513205

TYPUS in matrice *Carex maorica*, New Zealand, North Island, Wellington, Trentham, 25.III.1953, leg. A.J. Healy. *Holotypus* PDD 12100, *isotypus* HUV 19059. *Paratypus in matrice* *Carex fascicularis*, New Zealand, North Island, Auckland, Bethells Swamp, XI.1955, leg. J.M. Dingley, PDD 15571, *isoparatypus* HUV 18751!

Sori in floribus nonnullis inflorescentiae, massa sporarum olivaceobrunnea, pulvereae, cum fasciculis longis, numerosis filamentorum funga lium sterilium mixta. Sporae globosae, subglobosae, ovoideae, ellipsoidales, raro elongatae, 3–5.5 × 3–7(–7.5) μm, pallide olivaceobrunneae; pariete aequaliter 1–1.5 μm crasso, leniter dense irregulariter verruculoso, verrucis interdum in seriebus brevibus ordinatis, imago obliqua sporarum sinuata usque leniter serrulata.

SORI (FIG. 3) in some flowers of an inflorescence, spore mass olivaceous brown, powdery, mixed with numerous long fascicles of sterile fungal filaments. SPORES (FIGS. 8, 9) globose, subglobose, ovoid, ellipsoidal, rarely elongated, 3–5.5 × 3–7(–7.5) μm, pale olivaceous brown; wall evenly 1–1.5 μm thick, finely, densely, irregularly verruculose, warts rarely in short rows, spore profile wavy to finely serrulate.

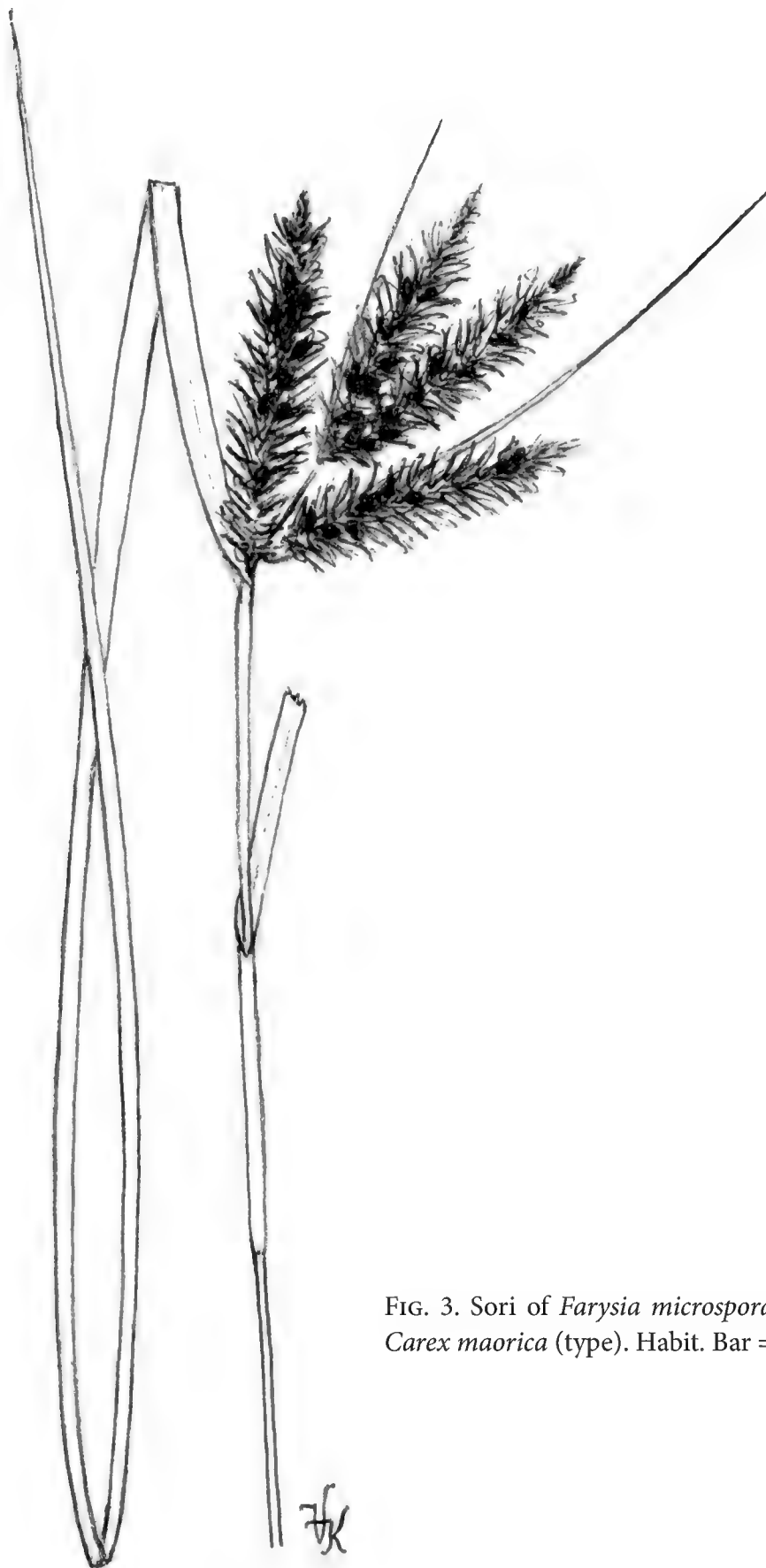


FIG. 3. Sori of *Farysia microspora* in some flowers of *Carex maorica* (type). Habit. Bar = 1 cm.

On *Cyperaceae*: *Carex*, subgen. *Carex*, sect. *Pseudocypereae*, *C. fascicularis* Boott, *C. maorica* Hamlin; New Zealand. Known only from the type collections.

Typical for *Farysia microspora* is the relatively small size of the variable spores.

A new species of *Antherospora* (*Floromycetaceae*) on *Eucomis*

For *Ustilago* species on *Liliaceae* s. l., Ershad (2000: 66) proposed the genus *Vankya*, with three species: 1. *V. ornithogali* (J.C. Schmidt & Kunze) Ershad (on *Gagea* and *Ornithogalum*), 2. *V. heufleri* (Fuckel) Ershad (on *Erythronium* and *Tulipa*), and 3. *V. vaillantii* (Tul. & C. Tul.) Ershad, on several host plant genera. Ultrastructural and molecular analyses revealed that *V. vaillantii* is generically different from the other two species of *Vankya*. For it the genus *Antherospora* R. Bauer et al. (Bauer et al. 2008) was proposed, with the type *A. vaillantii* (Tul. & C. Tul.) R. Bauer et al., on *Muscari comosum* (L.) Mill. A further six species were placed in this genus, all on members of *Hyacinthaceae* (*Liliaceae* s. l.). An additional new species is:

Antherospora eucomis Vánky, sp. nov.

MYCOBANK MB 513206

TYPUS in matrice *Eucomis punctata*, South Africa, Cape Prov., Kentani Distr., Kentani, 12.XII.1914, leg. A. Pegler. *Holotypus* HUV 18257!; *isotypus* PREM 8795. *Paratypus ibidem*, 12.XII.1911, A. Pegler, PREM 2001, *isoparatypus* BPI 169328!

Sori in antheris et ad superficiem organorum floralium interiorum, flores massa sporum nigrescentibrunnea, pulverea implentes, involucris floralibus externis cooperti. Sporae globosae, subglobosae, ovoideae, ellipsoidales, elongatae vel parum irregulares, 5.5–8(–9) × 7–12(–13.5) μm, flavidobrunneae; pariete aequali, cca. 0.5 μm crasso, leniter, dense verruculoso, imago oblique sporarum leniter aspera.

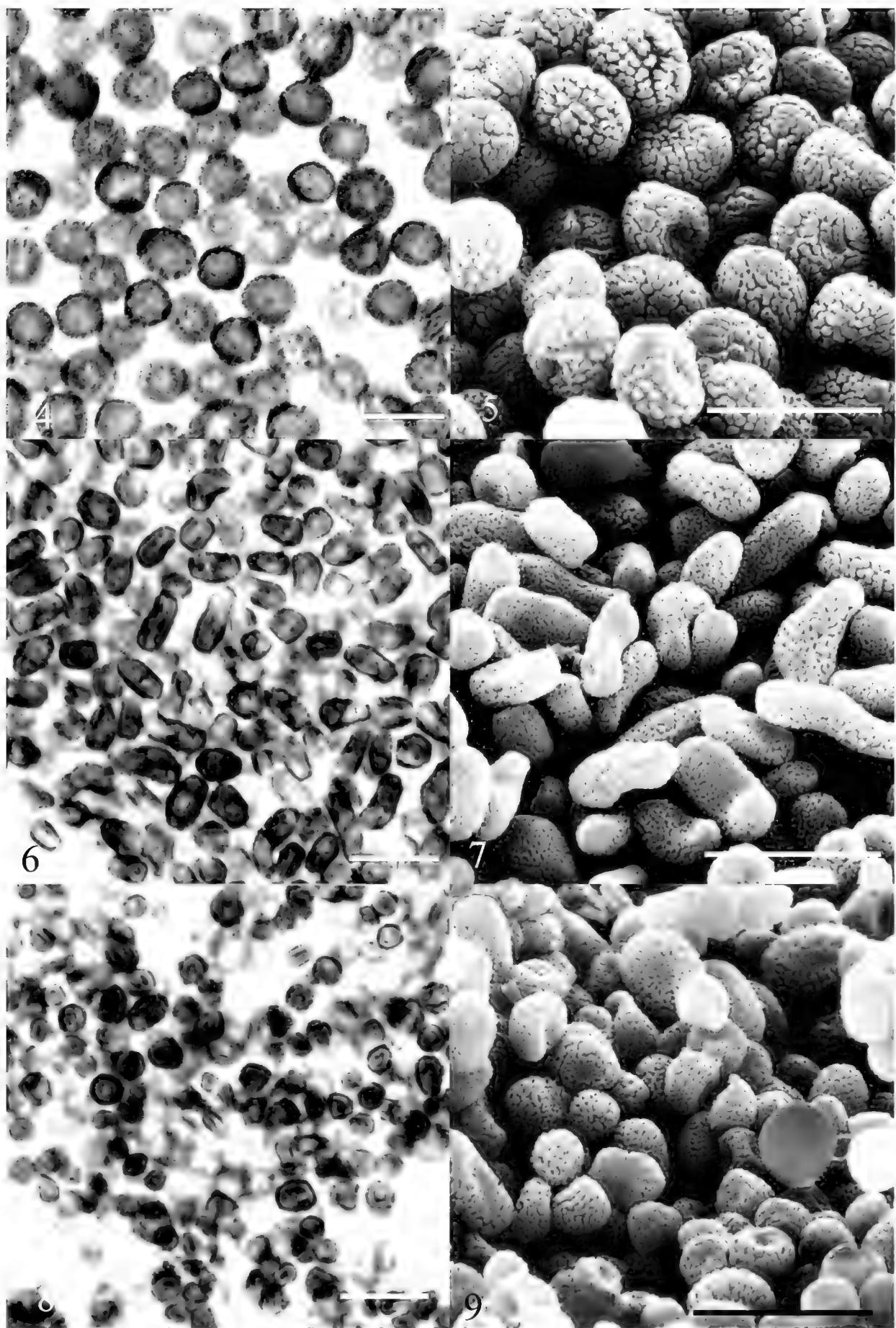
SORI (FIG. 10) in the anthers and on the surface of inner floral organs, filling the swollen, deformed flowers with a blackish brown, powdery mass of spores, covered by the outer floral envelopes. SPORES (FIGS. 14, 15) globose, subglobose, ovoid, ellipsoidal, elongated or slightly irregular, 5.5–8(–9) × 7–12(–13.5) μm, yellowish brown; wall even, c. 0.5 μm thick, finely, densely verruculose, spore profile finely rough.

On *Hyacinthaceae* (*Liliaceae* s. l.): *Eucomis punctata* (Thunb.) L'Hér.; South Africa.

Typical for *Antherospora eucomis* are the relatively regular, small spores formed in swollen, deformed flowers.

Key to the species of *Antherospora*

1. Sori mainly in the anthers; flowers not or only slightly deformed 2
- Sori in all inner floral organs; flowers deformed, swollen 5
2. On *Muscari*. Spores 6.5–12(–14) μm long *A. vaillantii*
- Not on *Muscari* 3



FIGS.4–9. Spores in LM (left) and SEM (right). Bars = 10 μm. FIGS. 4–5. *Farysia globispora* on *Carex appressa* (type). FIGS. 6–7. *Farysia longispora* on *Carex dipsacea* (type). FIGS. 8–9. *Farysia microspora* on *Carex maorica* (type).

- 3. On *Ornithogalum*. Spores 9–24(–27) μm long; spore wall c. 0.5 μm thick *A. peglerae*
- On *Scilla*. Spores 7–11.5(–13) μm long; spore wall 0.8–1.5 μm thick 4
- 4. On *S. bifolia* *A. scillae*
- On *S. vindobonensis* (a cryptic species) *A. vindobonensis*
- 5(1). Spores 9.5–22.5 μm long. On *Albuca* *A. albucae*
- Spores smaller. Not on *Albuca* 6
- 6. Spores regular, 7–12(–13.5) μm long. On *Eucomis* *A. eucomis*
- Spores more or less irregular, up to 15(–17.5) μm long. Not on *Eucomis* 7
- 7. Spore wall 0.5–0.8 μm thick. On *Urginea* *A. urgineae*
- Spore wall c. 0.5 μm thick. On *Bellevallia* *A. tourneuxii*



10

11

FIG. 10. Sori of *Antherospora eucomis* in all flowers of *Eucomis punctata* (type).

FIG. 11. Sori of *Moreaua peckii* in the flowers of *Schoenus cruentus* (type).

Habit. To the left a healthy inflorescence. Bars = 1 cm

Four new species of *Moreaua* (Anthracoideaceae)

The genus *Moreaua* Liou & H.C. Cheng, within the *Anthracoideaceae* family, has 31 known species, parasitising plants in 17 genera of *Cyperaceae*. On *Schoenus* three species of *Moreaua* are known: 1. *M. kochiana* (Gäum.) Vánky 2000 (type on *S. nigricans* L. × *S. ferrugineus* L., Switzerland), 2. *M. laevigata* (Websdane & Vánky) Vánky 2000 (type on *S. laevigatus* W. Fritzg., Australia), and 3. *M. schoeni* (Vánky & McKenzie) Vánky 2000 (type on *S. brevifolius* R. Br., New Zealand). An additional species was discovered in the mycological herbarium PERTH, incorrectly determined by the unknown collector as *Sorosporium solidum* (Berk.) McAlpine 1910. It is described as:

Moreaua peckii Vánky & R.G. Shivas, sp. nov.

MYCOBANK MB 513207

Typus in matrice *Schoenus cruentus*, Australia, Western Australia, Albany, 35°02'53" S, 117°53'47" E, 14.III.1955. **Holotypus** PERTH 780278, *isotypi* BRIP 49111, HUV 17587!

Sori ad superficiem organorum floralium internarum massam nigram glomerulorum sporarum primum agglutinatum serius granulosopulveream perfecte tegenter involucris floralibus maxime externis formantes. Glomeruli sporarum globosi, subglobosi, ovoidei, ellipsoidales, elongati vel parum irregulares, magnitudine variabiliter, 40–80 × 50–100 (–120) µm, rubrobrunnei usque subopaci, e pluribus decem sporarum pressu satis facili separabili compositi. Sporae in visu superficiali rotundae vel elongatae, subpolyangulariter irregulares, 7–11 × 8–16 µm, in visu opticaliter mediano subcuneiformes, raro cuneiformes, elongatae vel parum irregulares, 16–28(–32) µm longae, flavidae vel olivaceobrunneae; pariete inaequali, in superficie libera 4–9 µm crasso, leniter verruculoso et squamis irregularibus, pressu devenientibus velato, in latere contacto cca. 0.5 µm crasso, levi, pariete partis centralis, angustis ultimis sporarum 0.5–4 µm crasso, levi.

ETYMOLOGY: named in honour of the eminent American mycologist Charles Horton Peck (1833–1917), who described more than 2700 new species and varieties of North American fungi. Peck was also an excellent illustrator.

SORI (FIG. 11) on the surface of inner floral organs forming a black, first agglutinated, later granular powdery mass of spore balls, completely hidden by the outermost floral envelopes. **SPORE BALLS** (FIGS. 16, 17) globose, subglobose, ovoid, ellipsoidal, elongate to slightly irregular, variable in size, 40–80 × 50–100 (–120) µm, reddish brown to subopaque, composed of dozens of spores that separate rather easily by pressure. **SPORES** (FIGS. 16, 17) in surface view rounded or elongated, subpolyangularly irregular, 7–11 × 8–16 µm, in optical median view subcuneiform, rarely cuneiform, elongated or slightly irregular, 16–28(–32) µm long, yellowish or olivaceous brown; wall uneven, on the free surface 4–9 µm thick, finely verruculose and covered by irregular squamae that detach by pressure, on the contact sides c. 0.5 µm thick, smooth, wall of the central, narrow end of the spores 0.5–4 µm thick, smooth.

On *Cyperaceae*: *Schoenus cruentus* (Nees) Benth.; Australia. Known only from the type collection.

Key to the species of *Moreaua* on *Schoenus*

1. Spore balls separate by pressure; free spore wall 4–9 μm thick *M. peckii*
 – Spore balls firmly agglutinated; free spore wall thinner 2
2. Spore balls 60–120(–150) μm long; spores radially 12–30(–35) μm *M. schoeni*
 – Spore balls up to 85 μm long; spores radially shorter 3
3. Spores radially 6.5–18 μm long; free wall 1–3 μm thick, germ pore lacking
 *M. kochiana*
 – Spores radially 12–25 μm long, free wall 2.5–5 μm thick, germ pore present
 *M. laevigata*

On *Tetraria* two species of *Moreaua* are known, both on *T. capillaris* (F. Muell.) J.M. Black, from Australia (comp. Vánky & Shivas 2008): 1. *M. opaca* Vánky 2002 and 2. *M. tetrariae* (Vánky) Vánky 2000. Three additional species were collected in South Africa:

***Moreaua capillaceae* Vánky, sp. nov.**

MYCOBANK MB 513247

Typus in matrice *Tetraria capillacea* (det. C. Archer, PRE), South Africa, Western Cape Province, Cape Peninsula, Good Hope Nature Reserve, 34°15'54" S, 18°26'15" E, alt. 100 m.s.m., 14.XII.1996, leg. C. & K. Vánky. *Holotypus* HUV 18043!, *isotypi in* Vánky, *Ust. exs. no.* 1318.

Moreaua capillaceae similis *Moreauae opacae* Vánky (*Mycotaxon* 81: 371, 2002, *typus in matrice* *Tetraria capillaris*, Australia), *sed differt glomerulis sporarum majoribus* (50–150(–180) μm longis) *et pariete sporarum tenuiore ad superficiem liberam* (1–1.5 (–2.5) μm).

SORI (FIG. 12) on the surface of inner floral organs forming a black, first agglutinated, later granular powdery mass of spore balls, completely hidden by the outermost floral envelopes. SPORE BALLS (FIGS. 18, 19) subglobose, ovoid, ellipsoidal, elongate to irregular, 40–100(–130) \times 50–150(–180) μm , opaque, permanent, composed of dozens of spores that break rather than separate by strong pressure. SPORES (FIGS. 18, 19) in surface view polyangularly or subpolyangularly irregular, 6–12 \times 7–15.5 μm , in optical median view subcuneiform, elongate or slightly irregular, radially 9.5–24(–28) μm long, dark olive–brown; wall on the free surface 1–1.5 μm thick, at the angles up to 2.5 μm , verruculose, germ pore lacking, wall on the contact sides c. 0.5 μm thick, smooth.

On *Cyperaceae*: *Tetraria capillacea* (Thunb.) C.B. Clarke; South Africa. Known only from the type collection.

Moreaua capillaceae is similar to *M. opaca* from which it differs in having larger spore balls and thinner spore wall on the free surface. The spore balls of *M. opaca* are 25–55(–60) μm long and the spore wall on the free surface is 2–4.5 μm thick.



12 —



13 —



Moreaua eximiae Vánky, sp. nov.

MYCOBANK MB 513248

TYPUS in matrice *Tetraria eximia* (det. C. Archer, PRE), South Africa, Western Cape Province, Cape Peninsula, Mt. Swartkopberge, 34°12'57" S, 18°24'24" E, alt. 100 m.s.m., 13.XII.1996, leg. C. & K. Vánky. *Holotypus* HUV 18039!, *isotypi* in Vánky, Ust. exs. no. 1319.

Moreaua eximiae similis *Moreauae opacae* Vánky (Mycotaxon 81: 371, 2002, *typus in matrice* *Tetraria capillaris*, Australia), *sed differt glomerulis sporarum atro-rubrobrunneis, non opacis, sporis radialiter brevioribus* (9.5–16.5 µm longis) *et pariete sporae ad superficiem liberam glomerulorum tenuiore* (1–1.5(–2.5) µm).

SORI (FIG. 13) on the surface of inner floral organs forming a black, first agglutinated, later granular powdery mass of spore balls, completely hidden by the outermost floral envelopes. SPORE BALLS (FIGS. 21, 22) subglobose, ovoid, elongate to irregular, 30–70(–80) × (30–)40–80(–100) µm, dark reddish brown, not opaque, composed of dozens of spores that separate with difficulty by strong pressure. SPORES (FIGS. 21, 22) globose, subglobose, ovoid, ellipsoidal, subcuneiform, in surface view subcircular, ovoid or subpolyangularly irregular, 5.5–12 × 6–17 µm, radially 9.5–16 µm long, reddish brown; wall on the free surface 1–1.5(–2.5) µm thick, irregularly, sparsely verruculose, germ pore lacking, wall on the contact sides c. 0.5 µm thick, smooth.

On *Cyperaceae*: *Tetraria eximia* C.B. Clarke; South Africa. Known only from the type collection.

Moreaua eximiae is similar to *M. opaca* from which it differs in having dark reddish brown, non opaque spore balls, spores that are radially shorter and the spore wall on the free surface is thinner. In *M. opaca* the spore balls are opaque, the spores are 9–20(–25) µm long, and the spore wall on the free surface is 2–4.5 µm thick.

Moreaua tothii Vánky, sp. nov.

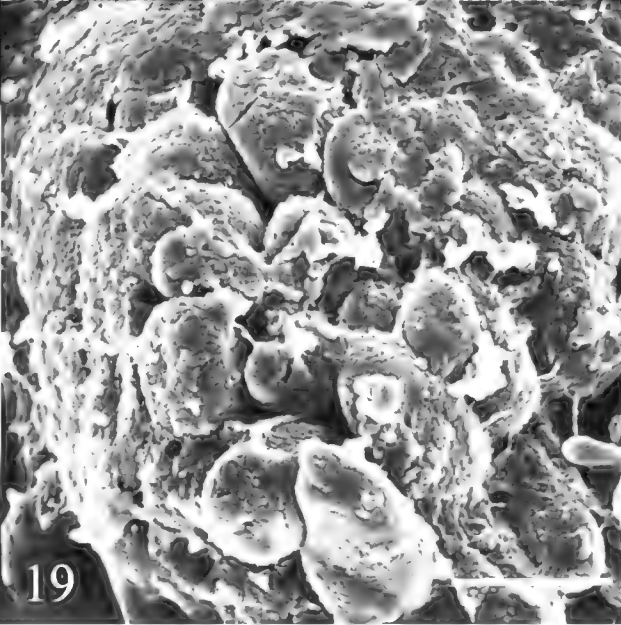
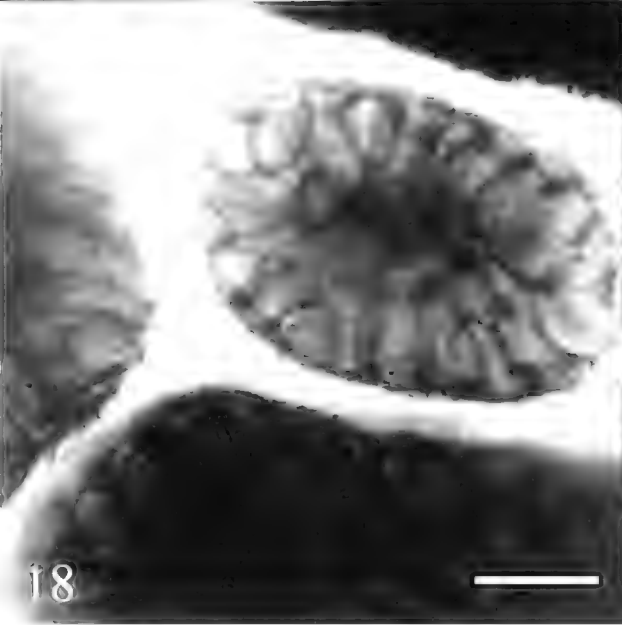
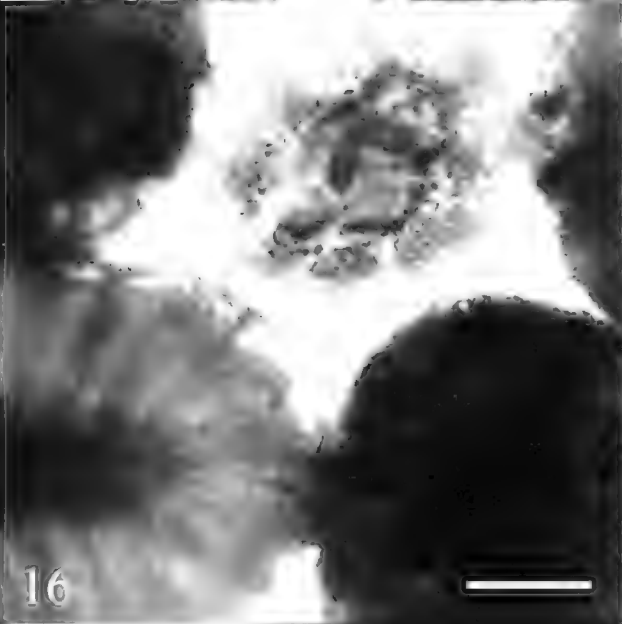
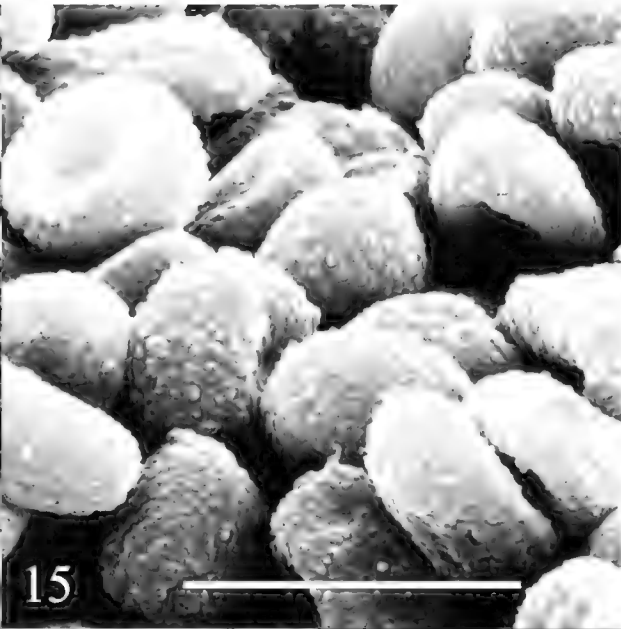
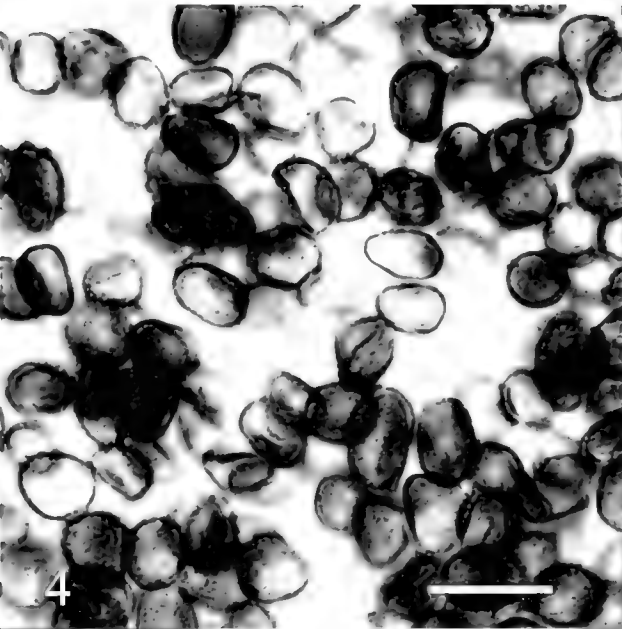
MYCOBANK MB 513249

TYPUS in matrice *Tetraria compar* (det. C. Archer, PRE), South Africa, Western Cape Province, Cape Peninsula, Silvermine Nature Reserve, Calc Bay Mt., 34°05'10" S, 18°25'18" E, alt. 300 m.s.m., 12.XII.1996, leg. C. & K. Vánky. *Holotypus* HUV 18042!, *isotypi* in Vánky, Ust. exs. no. 1317.

Moreaua tothii similis *Moreauae opacae* Vánky (Mycotaxon 81: 371, 2002, *typus in matrice* *Tetraria capillaris*, Australia), *sed differt colore atro-rubrobrunneo glomerulorum sporarum majore* (40–130(–160 µm longis) *et poro germinationis conspicuo superficiei liberae sporarum externarum glomerulorum*.

FIG. 12. Sori of *Moreaua capillaceae* in the flowers of *Tetraria capillacea* (type). Habit. FIG. 13. Sori of *Moreaua eximiae* in the flowers of *Tetraria eximia* (type). Habit. To the left a healthy inflorescence.

Bars= 1 cm.



ETYMOLOGY: named in the honour of the outstanding Hungarian mycologist, Dr. Sándor Tóth (1918–), a modest, unselfish, helpful, excellent human being and friend.

SORI (FIG. 20) on the surface of inner floral organs forming a black, first agglutinated, later granular powdery mass of spore balls, completely hidden by the outermost floral envelopes. SPORE BALLS (FIGS. 23, 24) subglobose, ovoid, ellipsoidal, elongate to irregular, variable in size, $35\text{--}90 \times 40\text{--}130\text{--}(160) \mu\text{m}$, dark reddish brown to opaque, composed of dozens of spores that separate with difficulty by strong pressure. SPORES (FIGS. 23, 24) in surface view polyangularly irregular, $6.5\text{--}12 \times 7\text{--}15 \mu\text{m}$, in optical median view subcuneiform, elongate or slightly irregular, $12\text{--}32 \mu\text{m}$ long, olive-brown; wall on the free surface $1.5\text{--}3 \mu\text{m}$ thick, verruculose and covered by irregular squamae, with a rounded, paler germ pore of $3\text{--}4 \mu\text{m}$ diameter, wall on the contact sides c. $0.5 \mu\text{m}$ thick, in LM smooth, in SEM very finely verruculose. Spores in the middle of large spore balls are globose, ovoid or ellipsoidal, usually with a $3\text{--}4 \mu\text{m}$ wide, shorter or longer appendage, the remnants of the sporogenous hyphae.

On *Cyperaceae*: *Tetraria compar* (L.) T. Lestib.; South Africa. Known only from the type collection.

Moreaua tothii is similar to *M. opaca* from which it differs in having dark reddish brown, larger spore balls, and an evident germ pore on the free wall of the outer spores. In *M. opaca* the spore balls are opaque, $25\text{--}55\text{--}(60) \mu\text{m}$ long, germ pore is lacking.

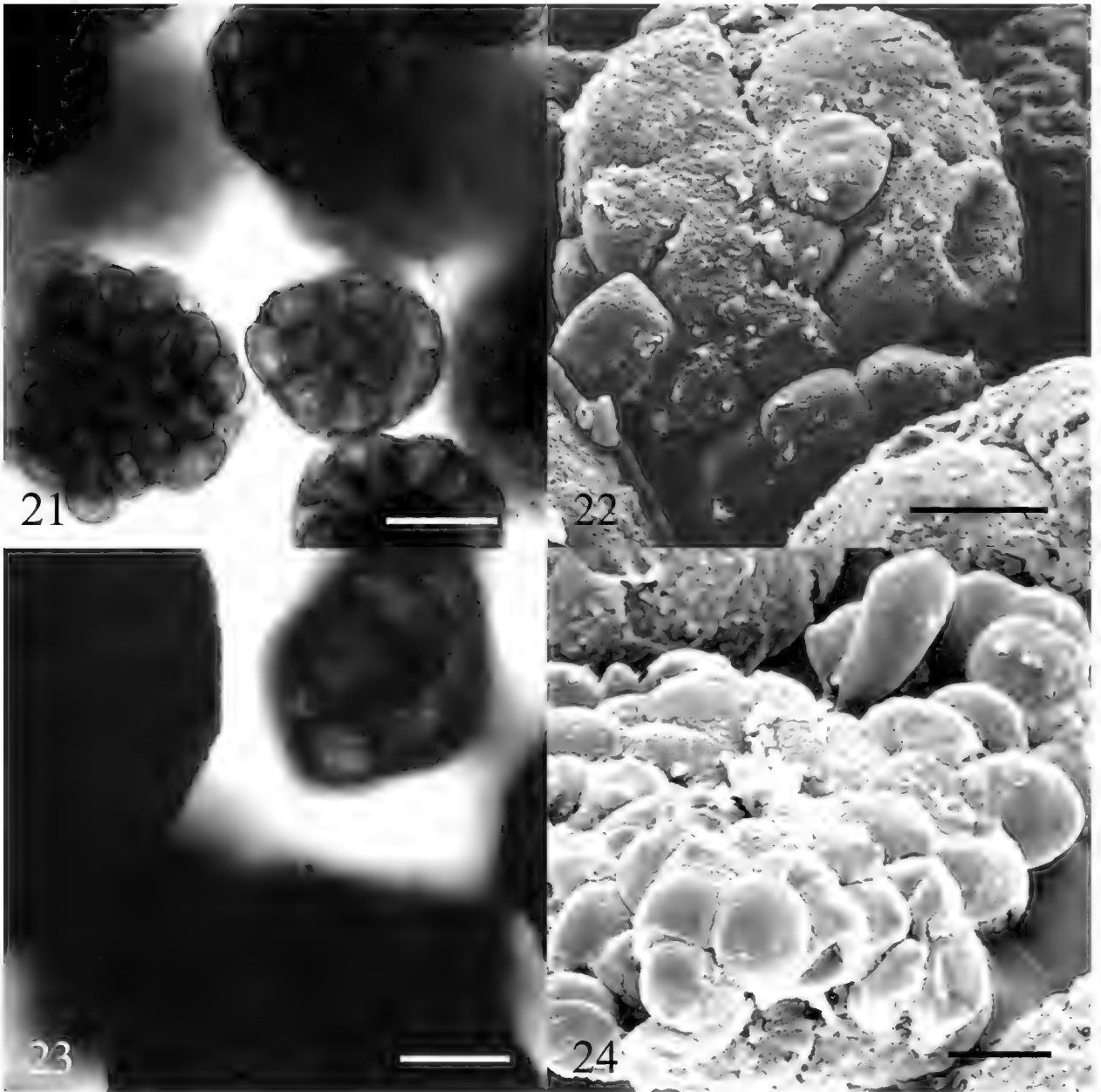
Key to the species of *Moreaua* on *Tetraria*

1. Free spore wall with evident germ pore *M. tothii*
- Free spore wall without germ pore 2
2. Spore balls $25\text{--}55\text{--}(60) \mu\text{m}$ long; free spore wall $2\text{--}4.5 \mu\text{m}$ thick *M. opaca*
- Spore balls larger; free spore wall thinner 3
3. Spores radially $9.5\text{--}16.5 \mu\text{m}$ long. On *T. eximia* *M. eximiae*
- Spores radially longer. Not on *T. eximia* 4
4. Spore balls opaque, $50\text{--}150\text{--}(180) \mu\text{m}$ long; spores radially $9.5\text{--}24\text{--}(28) \mu\text{m}$ long. On *T. capillacea* *M. capillaceae*
- Spore balls dark reddish brown, not opaque, $35\text{--}95\text{--}(105) \mu\text{m}$ long; spores radially $10\text{--}20 \mu\text{m}$ long. On *T. capillaris* *M. tetrariae*

FIGS. 14–19. LM (left) and SEM (right). Bars = $10 \mu\text{m}$. FIGS. 14–15. Spores in *Antherospora eucomis* on *Eucomis punctata* (type). FIGS. 16–17. Spore balls and spores of *Moreaua peckii* on *Schoenus cruentus* (type). FIGS. 18–19. Spore balls and spores of *Moreaua capillaceae* on *Tetraria capillacea* (type).



FIG. 20. Sori of *Moreaua tothii* in the flowers of *Tetraria compar* (type).
Habit. To the left a healthy inflorescence. Bar = 1 cm.



FIGS. 21–24. Spore balls and spores in LM (left) and SEM (right).

FIGS. 21–22. *Moreaua eximia* on *Tetraria eximia* (type).

FIGS. 23–24. *Moreaua tothii* on *Tetraria compar* (type).

A new species of *Entyloma* on *Eryngium alpinum* (Apiaceae)

A species of *Entyloma* on *Eryngium alpinum* was reported by Servazzi (1950), collected in Italy, Prov. Cuneo, Piedmont, alt. 1600–1700 m., VII.1949. Servazzi supposed that it could be a new species. *E. alpinum* is cultivated in large scale in several places of Switzerland as an ornamental (comp. Rüegg 1990). From such cultures, Adrian Bolay (G, Genève) repeatedly collected heavily infected leaves, attributed to *Entyloma eryngii* (Corda) de Bary 1874. *Entyloma* on *Eryngium alpinum* differs from *E. eryngii* (type on *Eryngium campestre* L.) in sorus and spore morphology. Six *Entyloma* species have been described on various *Eryngium* species with more or less expressed morphological difference of the

spores and sori. It seems that each *Eryngium* species has its own *Entyloma* species. Recent molecular phylogenetic works (Begerow et al. 2002) showed also that in many cases smut fungi, especially *Entyloma* species evolved together with their host plants. Consequently, it seems adequate to consider the smut on *Eryngium alpinum* a separate species:

***Entyloma eryngii-alpini* Vánky, sp. nov.**

MYCOBANK MB 514044

TYPUS in matrice *Eryngium alpinum* cult., Switzerland, Kanton Graubünden, Frauenkirch prope Davos, 46°46'43" N, 9°49'02" E, alt. cca. 1525 m.s.m., 12.VIII.1987, leg. A. Bolay.

Holotypus HUV 21598, *isotypus* in G. *Paratypus* Kanton Graubünden, Basse Engadine, Ftan, 46°47'50.46" N, 10°15'16" E, alt. 1690 m, 20.VII.1987, leg. A. Bolay, HUV 21597, G.

Entyloma eryngii-alpini differt a specie *Entyloma eryngii* (Corda) de Bary (Bot. Zeitung (Berlin) 32: 105, 1874) soris planis, sporis minoribus (8–14 µm longis) et pariete earum tenuiori (1–2.5 µm); atque anamorphae praesenti.



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FIG. 25. Sori of *Entyloma eryngii-alpini* on a leaf of *Eryngium alpinum* (type).

Habit. Bar = 1 cm.

SORI (FIG. 25) on the leaves forming initially yellowish white, later brownish, flat, polyangular spots, 0.5–1 mm in diam. or larger by confluence, delimited by leaf veins, sometimes covering large parts of the leaves. SPORES (FIG. 30) embedded in the leaf tissue, crowded, globose, subglobose, ovoid, ellipsoidal or irregular, with one or several slightly flattened sides, $8\text{--}13 \times 8\text{--}14 \mu\text{m}$, subhyaline to pale yellowish tinted; wall evenly or unevenly $1\text{--}2.5 \mu\text{m}$ thick, smooth. ANAMORPH may be present on the abaxial side of the leaves with slightly bent conidia, $2\text{--}2.5 \times 12\text{--}16 \mu\text{m}$, protruding from the stomata.

On *Apiaceae*: *Eryngium alpinum* L.; Europe (Italy, Switzerland).

Entyloma eryngii-alpini differs from *E. eryngii* in having flat sori, smaller spores ($8\text{--}14 \mu\text{m}$ long) and thinner spore wall ($1\text{--}2.5 \mu\text{m}$); anamorph present. In *E. eryngii* the sori are often bullate, the spores are $10.5\text{--}19 \mu\text{m}$ long, and the spore wall is $2.5\text{--}6(7.5) \mu\text{m}$ thick; anamorph absent.

A tentative key to the species of *Entyloma* on *Eryngium*, based mainly on host plant taxonomy

1. On *Er. campestre*; spores $10.5\text{--}19 \mu\text{m}$ long; wall $2.5\text{--}6(7.5) \mu\text{m}$ thick *E. eryngii*
– Not on *Er. campestre*; spores smaller; wall thinner 2
2. On *Er. nudicaule*; spores $10\text{--}17 \mu\text{m}$ long; wall $1.5\text{--}5 \mu\text{m}$ thick ... *E. argentinense*
– Not on *Er. nudicaule*; spores smaller; wall thinner 3
3. On *Er. dichotomum*; spore wall $1.5\text{--}3 \mu\text{m}$ thick. *E. eryngii-dichotomi*
– Not on *Er. dichotomum*; spore wall thinner 4
4. On *Er. planum*; spore wall even, $1\text{--}2.5 \mu\text{m}$ thick *E. eryngii-planii*
– Not on *Er. planum*; spore wall even or uneven, thinner or same thickness 5
5. On *Er. maroccanum*; sori thickened; spore wall $0.8\text{--}1.5 \mu\text{m}$ thick
..... *E. maroccanum*
– Not on *Er. maroccanum*; sori flat; spore wall thicker 6
6. On *Er. alpinum*; wall $1\text{--}2.5 \mu\text{m}$ thick; anamorph present *E. eryngii-alpini*
– On *Er. tricuspidatum*; wall $1.5\text{--}2 \mu\text{m}$ thick; anamorph absent
..... *E. eryngii-tricuspidati*

Ustilago piptatheri sp. nov. on *Piptatherum* (*Poaceae*) from Spain

Piptatherum P. Beauv. is a small genus in the tribe *Stipeae* of the subfam. *Pooideae*. It is closely related with *Oryzopsis* Michx. The two genera were also merged by several authors. On members of these two genera the following six smut fungi are known: 1. *Ustilago athenae* Maire 1917 (type on *Oryzopsis miliacea* (L.) Benth. & Hook. f. ex Asch. & Schweinf.) = *Tranzscheliella hypodytes* (Schltdl.) Vánky & McKenzie 2002, 2. *T. minima* (Arthur) Vánky 2003 (type on *Oryzopsis cuspidata* (Nutt.) Benth. ex Vasey), 3. *T. williamsii* (Griffiths) Dingley

& Versluys 1977 (type on *Stipa richardsonii* Link), 4. *Urocystis oryzopsidis* Padwick & A. Khan 1944 (type on *Oryzopsis munroi* Stapf), 5. *Ustilago rechingeri* Săvul. 1937 (type on *Oryzopsis coerulescens* (Desf.) Hack.), and 6. *U. striiformis* (Westend.) Niessl 1876 (type on *Holcus lanatus* L.). An additional name, *Ustilago centrodomis* E. Duval et al. 1975, on *Oryzopsis hymenoides* (Roem. & Schult.) Ricker was invalidly published (no type indicated). On *Piptatherum paradoxum* there is an additional smut fungus, which is described as:

***Ustilago piptatheri* Vánky, sp. nov.**

MYCOBANK MB 514045

TYPUS in matrice *Piptatherum paradoxum*, Spain, Pancorbo, 42°37'27" N, 03°06'31" W, alt. c.c.a. 650 m.s.m., sine date, leg. Sennen et Elias. *Holotypus* HUV 21590.

Sori in spiculis omnibus inflorescentiae ejusdem, organa intima floralia et partem basalem involucrorum floralium destruentes, earum vicem massa sporarum nigrobrunnea, pulverea implentes, nonnunquam glumam primam vel etiam secundam intactam relinquentes. Sporae semiglobosae, latere uno impresso, in visu laterali 3.5–5 µm crassae, in visu plano circulares usque ellipticae, 5–6.5 × 5.5–8 µm, flavidobrunneae; pariete inaequali, 0.5–0.8 µm crasso, ad laterem planum tenue, ubi etiam pallidiore, superficie leniter punctata, imago obliqua sporae levis, vel in latere pallido leniter undulata.

SORI (FIG. 26) in all spikelets of an inflorescence destroying the innermost floral organs and the basal part of the floral envelopes, replacing them with a blackish brown, powdery mass of spores, sometimes leaving intact the first or even the second glume. SPORES (FIGS. 31, 32) hemiglobose, impressed on one side, in side view 3.5–5 µm wide, in plane view circular to elliptic, 5–6.5 × 5.5–8 µm, yellowish brown; wall uneven, 0.5–0.8 µm thick, thin on the flattened side, where the spores are also paler, surface finely punctate, spore profile smooth or very finely wavy on the paler side.

On *Poaceae*: *Piptatherum paradoxum* (L.) P. Beauv. (*Oryzopsis paradoxa* (L.) Nutt.; Europe. Known only from the type locality.

Ustilago piptatheri is closest to *U. rechingeri*, which completely destroys the spikelets, and has globose or subglobose spores.

***Urocystis vulpiae* sp. nov. on *Vulpia* (Poaceae) from Spain**

In HUV there is a collection under the name "*Tuburcinia* sp. on *Ventenata dubia*", obtained from the late Prof. C. Zambettakis (PC, Paris). The host plant is actually *Vulpia alopecuros* (subfam. *Pooideae*, tribe *Poeae*) and its smut is a new species:

***Urocystis vulpiae* Vánky, sp. nov.**

MYCOBANK MB 514046

TYPUS in matrice *Vulpia alopecuros*, Spain, Cádiz, prope urbem Rota, 36°38' N, 06°19' W, alt. cca. 5 m.s.m., 8.V.1969, leg. J. Mercé. *Holotypus* HUV 21590!



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FIG. 26. Sori of *Ustilago piptatheri* in all spikelets of an inflorescence of *Piptatherum paradoxum* (type). Habit. To the left a healthy inflorescence. Bar = 1 cm.

Urocystis vulpiae differt ab *Urocystis agropyri* (Preuss) A.A. Fisch. Waldh. (Bull. Soc. Imp. Naturalistes Moscou 40: 258, 1867, typus in matrice *Elymus repens* (L.) Gould) praecipue numero sporarum in glomerulis sporarum, colore atriore cellularum sterilium et



FIG. 27. Sori of *Urocystis vulpiae* on leaves and leaf sheaths of *Vulpia alopecuros* (type). Habit. To the left a healthy inflorescence. Bar = 1 cm.

propter genera plantarum nutrientium valde aliena: Vulpia in Poeae, Elymus in Triticeae (subfam. Pooideae).

SORI (FIG. 27) on leaves, leaf sheaths and stems as long, lead-coloured striae between the veins, rarely on floral envelopes of aborted inflorescence as pustules, at first covered by the epidermis that ruptures disclosing the dark brown, powdery mass of spore balls. SPORE BALLS (FIGS. 33, 34) globose, ovoid or ellipsoidal, 16–30 × 16–40 µm, medium dark reddish brown, composed of 1–3(–5) spores completely invested by sterile cells. SPORES (FIGS. 33, 34) globose, ovoid, ellipsoidal or irregular, with one or two flattened sides, 9.5–13.5 × 12–18.5 µm, reddish brown; wall evenly c. 1 µm thick, apparently smooth. STERILE CELLS (Figs. 33, 34) subglobose, ellipsoidal to slightly irregular, 6.5–15 µm long, reddish brown; wall smooth, unevenly 0.8–1.5 µm thick, thin on the free surface which is impressed in old specimens.

On *Poaceae*: *Vulpia alopecuros* (Schousb.) Dumort.; Europe. Known only from the type locality.

Urocystis vulpiae differs from *U. agropyri* especially in the number of spores per spore ball, in the darker colour of the sterile cells, and the host plant genera which belong to different tribes, *Vulpia* to *Poeae*, *Elymus* to *Triticeae* of the subfam. *Pooideae*. The number of spores per spore ball in *U. vulpiae*, counted for 500 balls, is: 1 = 49.4%, 2 = 38%, 3 = 11.8%, 4 = 0.6%, 5 = 0.2%. For *U. agropyri* (on *Elymus repens*, in Vánky, Ust. exs. no. 236) it is: 1 = 74.2%, 2 = 23.8%, 3 = 2%. A closely related smut fungus occurs on *Cynosurus cristatus* L. (tribe *Poeae*; Switzerland, HUV 21612) in which the number of spores per spore ball is similar to that of *U. vulpiae*, the sterile cells are yellowish brown, completely or incompletely surrounding the spores.

A new species of *Urocystis* on *Pulsatilla alba* from the Tatra Mts.

On *Pulsatilla* (*Ranunculaceae*) two *Urocystis* species are known. *U. pulsatillae* (Bubák) Moesz 1950 (type on *P. patens* (L.) Mill., Czech Rep.) and *U. qinghaiensis* L. Guo 2002 (type on *P. chinensis* (Bunge) Regel, China). The collective species *U. sorosporioides* Körn. ex A.A. Fisch. Waldh. (type on *Thalictrum minus* L., Germany) given on *P. styriaca* (Pritz.) Simonk. (= *P. halleri* subsp. *halleri*) from Hungary (Husz 1921: 101), must be an incorrect identification. A different species occurs on *P. alba* in the Tatra Mountains (comp. also Vánky 1994: 303). It is described as:

Urocystis pulsatillae-albae Vánky & Tóth, sp. nov.

MYCOBANK MB 514047

Typus in matrice *Pulsatilla alba*, Slovakia, Mt. Vysoké Tatry, in valle Furkotská dolina, 49°09'22" N, 20°01'42" E, alt. cca. 2000 m.s.m., 26.VIII.1979, leg. S. Tóth et K. Vánky.

Holotypus HUV 8873!, *isotypus* in BP. *Paratypi* in matrice *Pulsatilla alba*, *ibidem*, VII.1924, leg. J. Hruby, HUV 2954!, et Slovakia, Mt. Bielské Tatry, Faixova lonka, 13.VII.1949, leg. M. Součková, HUV 6240!



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FIG. 28. Sori of *Urocystis pulsatillae-albae* on leaves and petioles of *Pulsatilla alba* (type). Habit. To the left a fruiting healthy inflorescence. Bar = 1 cm.

Urocystis pulsatillae-albae differt a specie *Urocystis pulsatillae* (Bubák) Moesz (A Kárpát-medence üszöggombái, p. 211, 1950) principaliter glomerulis sporarum majoribus (20–52 (–65) μm longis) e sporis 1–7(–8) compositis et a strato cellularum sterilius plus-minus complete circumdatis.

SORI (FIG. 28) as blister-like swellings on leaves, petioles and stems, often confluent and causing distortions, first covered by the epidermis which ruptures disclosing the black, powdery mass of spore balls. SPORE BALLS (FIG. 35) subglobose, ellipsoidal, elongate or irregular, 16–40 \times 20–52(–65) μm , reddish brown, composed of 1–7(–8) spores completely or nearly completely surrounded by sterile cells. SPORES (FIG. 35) subglobose, ovoid, ellipsoidal, elongate, usually irregular with one or several flattened sides, 12–17.5 \times 14.5–21.5(–24) μm , reddish brown; wall c. 1 μm thick, smooth. STERILE CELLS (FIG. 35) ellipsoidal, 8–14.5 μm long, yellowish brown; wall uneven, 1–1.5 μm thick on the contact sides, c. 0.5 μm thick on the free surface, smooth, collapsed in old specimens.

On *Ranunculaceae*: *Pulsatilla alba* Rchb.; Europe (Carpathian Mts.).

Urocystis pulsatillae-albae differs from *U. pulsatillae* especially by larger spore balls composed of more spores and a \pm completely surrounding layer of sterile cells. The number of spores per spore ball, counted for 500 balls, is: 1 = 8%, 2 = 31.6%, 3 = 25.2%, 4 = 22%, 5 = 8.8%, 6 = 2.4%, 7 = 1.6%, 8 = 0.4%. In *U. pulsatillae* the spore balls are 16–40 μm long, composed 1–5 spores (1 = 26%, 2 = 42%, 3 = 22.6%, 4 = 7.4%, 5 = 2%) and an incompletely investing layer of sterile cells. *U. pulsatillae-albae* differs also from *U. qinghaiensis*, with spore balls composed of 1–10(–13) spores which are also smaller (10.5–16 μm long). *Pulsatilla alba* can be parasitized also by *U. pulsatillae*.

Key to the species of *Urocystis* on *Pulsatilla*

1. Spores per spore ball 1–5; layer of sterile cells incomplete *U. pulsatillae*
- Spores per spore ball more; layer of sterile cells \pm complete 2
2. Spores per spore ball 1–7(–8); spores 14.5–21.5(–24) μm long
 *U. pulsatillae-albae*
- Spores per spore ball 1–10(–13); spores 10.5–16 μm long *U. qinghaiensis*

Sporisorium schizachyrii-sanguinei sp. nov. from Mexico

On species of *Schizachyrium* and the closely related *Andropogon* (*Poaceae*, subfam. *Panicoideae*, tribe *Andropogoneae*, subtribe *Andropogoninae*) there are 36 known *Sporisorium* species (Vánky, in press). Between smut fungi obtained in exchange from Prof. Ruben Durán (Pullman, USA), there is a collection on *Andropogon hirtiflorus* (Nees) Kunth (= *Schizachyrium sanguineum*) under the name *Sorosporium provinciale*, collected in Mexico. Its study showed that it represents a new species:



FIG. 29. Sori of *Sporisorium schizachyrii-sanguinei* in the racemes of *Schizachyrium sanguineum* (type). Habit. To the left a healthy inflorescence. Bar = 1 cm.

***Sporisorium schizachyrii-sanguinei* Vánky, sp. nov.**

MYCOBANK MB 514048

TYPUS in matrice *Schizachyrium sanguineum*, Mexico, Chiapas, 20.2 km N of junction of Hwys 190 and 195, alt. 1066 m.s.m., 24.XI.1974, leg. R. Durán. *Holotypus* HUV 14406!, *isotypus* WSP 68305.

Sori racemos destruentes, lineares, 2.5–3 cm longi, 0.5–1 mm lati, partim spathis occulti, initio peridio tenui cooperti, quo irregulariter rupto massam nigrobrunneam, granuloso-pulveream glomerulorum sporarum et columellam longam, tenuem, filiformem ostendentes. Glomeruli sporarum subglobosi, ovoidei, ellipsoidales, elongati vel parum irregulares, 35–70 × 40–120 µm, mediocriter atro-rubrobrunnei, e pluribus decem sporarum facile separabilium compositi. Sporae subglobosae, ovoideae, ellipsoidales, elongatae vel irregulares, 9–13.5 × 9.5–16 µm, flavidobrunneae cum areis leviter pallidioribus et atrioribus; pariete inaequaliter 0.5–1.5 µm crasso, subtiliter verruculoso, imago obliqua sporarum levis. Cellulae steriles absentes.

SORI (FIG. 29) destroying the racemes, linear, 2.5–3 cm long, 0.5–1 mm wide, partly hidden by the spathae, initially covered by a thin peridium that ruptures irregularly disclosing the blackish brown, granular-powdery mass of spore balls and a long, slender, filiform columella. SPORE BALLS (FIGS. 36, 37) subglobose, ovoid, ellipsoidal, elongate or slightly irregular, 35–70 × 40–120 µm, medium dark reddish brown, composed of tens of spores that separate easily. SPORES (FIGS. 36, 37) subglobose, ovoid, ellipsoidal, elongate or irregular, 9–13.5 × 9.5–16 µm, yellowish brown with slightly paler and darker areas; wall unevenly 0.5–1.5 µm thick, finely verruculose, spore profile smooth. STERILE CELLS absent.

On *Poaceae*: *Schizachyrium sanguineum* (Retz.) Alston (*S. hirtiflorum* Nees); N. America. Known only from the type collection.

Sporisorium schizachyrii-sanguinei differs from *S. provinciale* (Ellis & Galloway) Vánky & Snets. 1990, in which the sori are up to 12 cm long, with several, interwoven columellae, and the spores are 13–19 µm long, with 3–4 µm thick wall. Further smut fungi on *Schizachyrium sanguineum* are: *Sporisorium absconditum* Vánky 2003, *S. andropogonis* (Opiz) Vánky 1985, *S. berndtii* Vánky 2003, *S. guaraniticum* (Speg.) Vánky 1989, and *S. schizachyrii* Vánky 2002.

Key to the *Sporisorium* species of *Schizachyrium sanguineum*

1. Sterile cells present; columella rather thick *S. andropogonis*
- Sterile cells absent; columella filiform 2
2. Sori in spikelets 3
- Sori in racemes 4
3. Sori in all sessile spikelets; columella one; spores dimorphic *S. schizachyrii*
- Sori in some sessile spikelets; columellae several; spores not dimorphic *S. berndtii*
4. Spore balls persistent; spores dimorphic *S. absconditum*
- Spore balls loose; spores not or only slightly dimorphic 5

- 5. Spores 13–20 µm long; spore wall 2.5–4 µm thick *S. guaraniticum*
- Spores 9.5–16 µm long; spore wall 0.5–1.5 µm thick . . *S. schizachyrii-sanguinei*

A new *Macalpinomyces* on *Loudetiopsis* from Bolivia

A study of “*Sporisorium tristachyae*” on *Loudetiopsis chrysothrix* from Bolivia revealed that it represents a new species, which is described as:

***Macalpinomyces loudetiopsidis* Vánky, sp. nov.**

MYCOBANK MB 514061

TYPUS in matrice Loudetiopsis chrysothrix, Bolivia, Depto. Santa Cruz, Prov. Samaipata, El Fuerte, cca. 18°10’41.78” S, 63°49’13.16” W, alt. cca. 1905 m.s.m., 30.I.2000, leg. M. Piepenbring et al. 2630, *Holotypus* LPB!

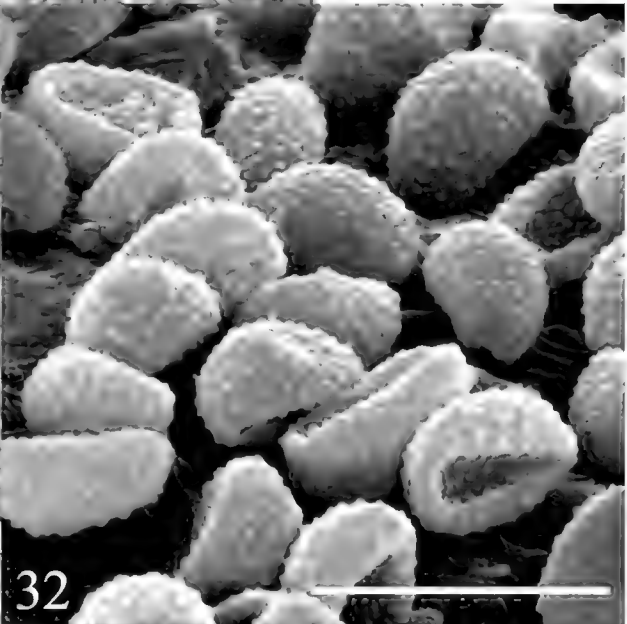
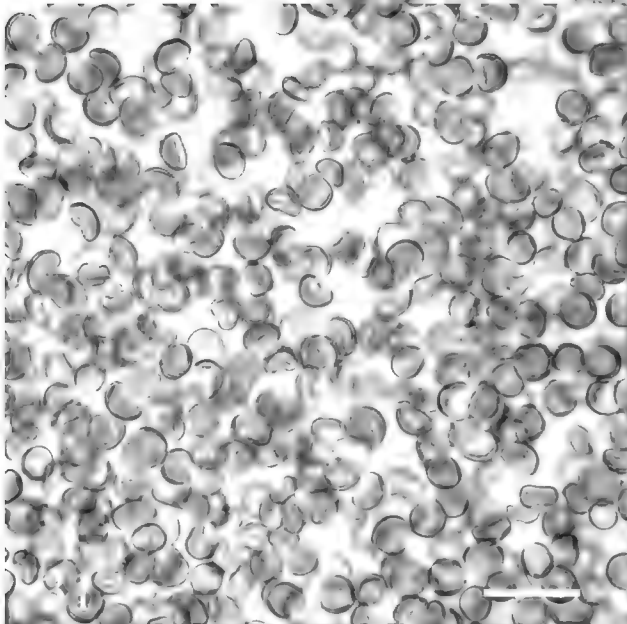
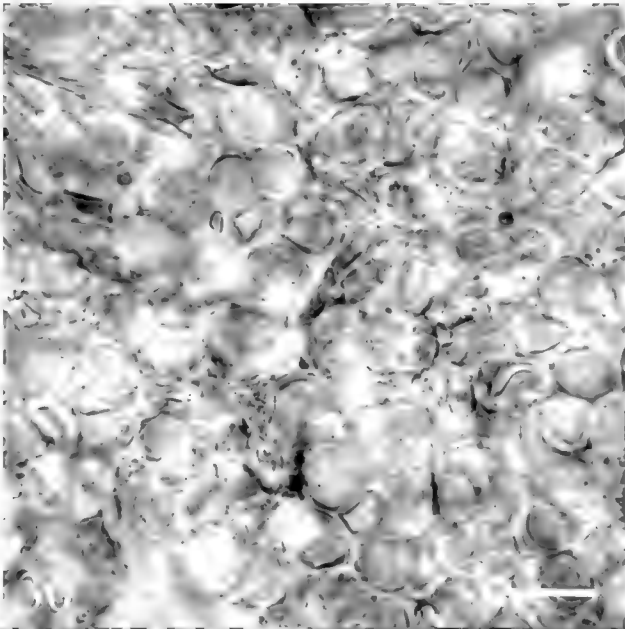
Macalpinomyces loudetiopsidis differt a specie *M. tristachyae* Vánky et C. Vánky (in Vánky, Mycotaxon 65: 165, 1997; *typus in matrice* Tristachya leucothrix Nees, South Africa) *spor. majoribus* (7–10.5 × 9–14(–15) µm), *pallidioribus*, *cum pariete aequaliter* 0.5–0.8 µm *crasso*, *leniter*, *dense punctato-verruculoso*; *cellulae steriles* 8–17.5 µm *longae*.

SORI on the top of sterile shoots, partly enclosed by the uppermost leaf sheath, elongated, tube-shaped, filled by a semiagglutinated to powdery mass of pseudo spore balls, spores and sterile cells. SPORE BALLS (FIGS. 38, 39) subglobose, ovoid, ellipsoidal or irregular, 50–100 × 60–140 µm, reddish brown, composed of numerous spores that separate easily. SPORES (FIGS. 38, 39) rounded subpolyangularly irregular, more rarely elongated and with a subacute tip, 7–10.5 × 9–14(–15) µm, pale yellowish brown; wall evenly 0.5–0.8 µm thick, finely, densely punctuate-verruculose, spore profile smooth. STERILE CELLS in irregular groups or single, subglobose, ellipsoidal or irregular, with one or several flattened sides, 5–15 × 8–17 µm, subhyaline; wall 0.5–2 µm thick, smooth.

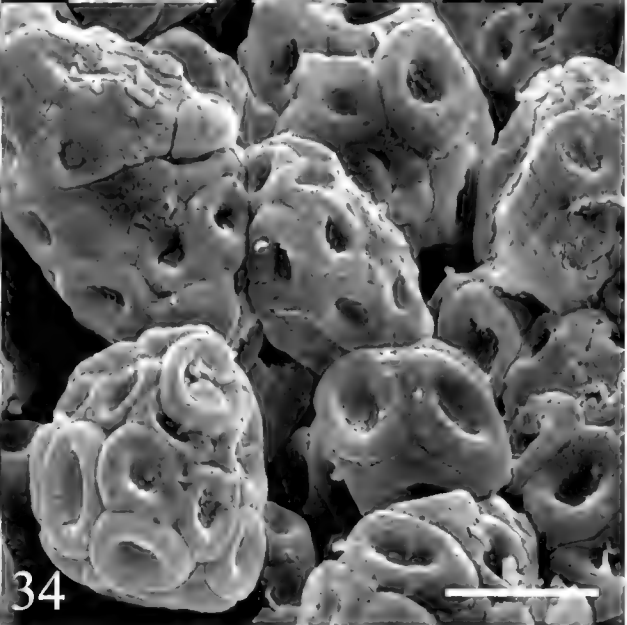
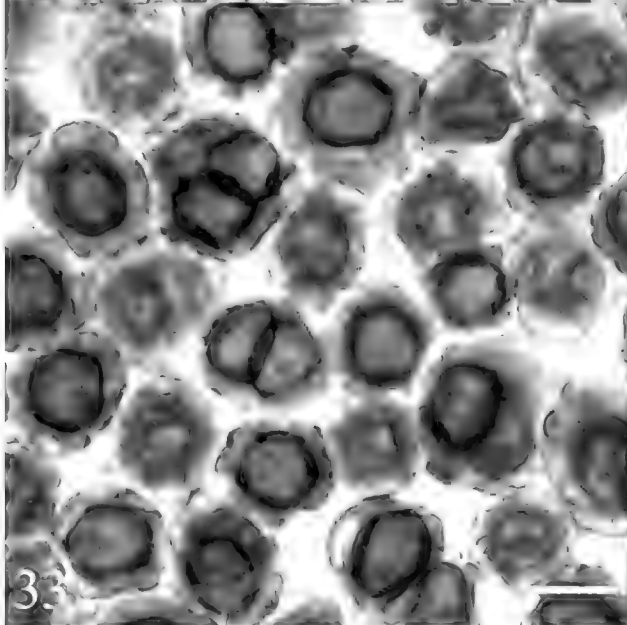
On *Poaceae*: *Loudetiopsis chrysothrix* (Nees) Cornert; South America (Bolivia). Known only from the type collection.

The checked specimen in LPB (La Paz, Bolivia), on which the description of this fungus is based, contained only a healthy inflorescence and spores in the envelope, no sori. Description of sori is taken from the literature. No additional specimens could be detected in the private collection of M. Piepenbring (pers. comm.), or in BPI, FR, M, TUB. This smut was reported by Piepenbring (2002: 54) as *Sporisorium tristachyae* (Vánky & C. Vánky) M. Piepenbr 2002, based on *Macalpinomyces tristachyae*). However, *Macalpinomyces loudetiopsidis* differs

FIG. 30. Spores of *Entyloma eryngii-alpini* on *Eryngium alpinum* in LM (type). FIGS. 31–32. Spores of *Ustilago piptatheri* on *Piptatherum paradoxum* in LM and in SEM (type). FIGS. 33–34. Spore balls, spores and sterile cells of *Urocystis vulpiae* on *Vulpia alopecuroides* in LM and in SEM (type). Bars = 10 µm.



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34

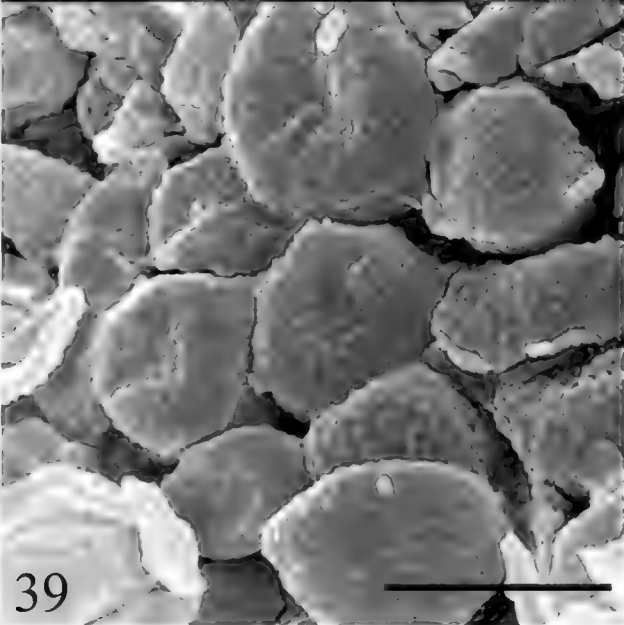
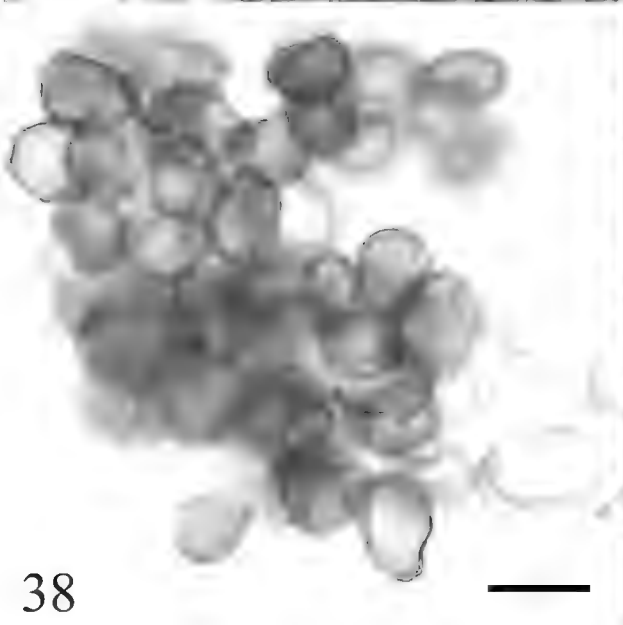
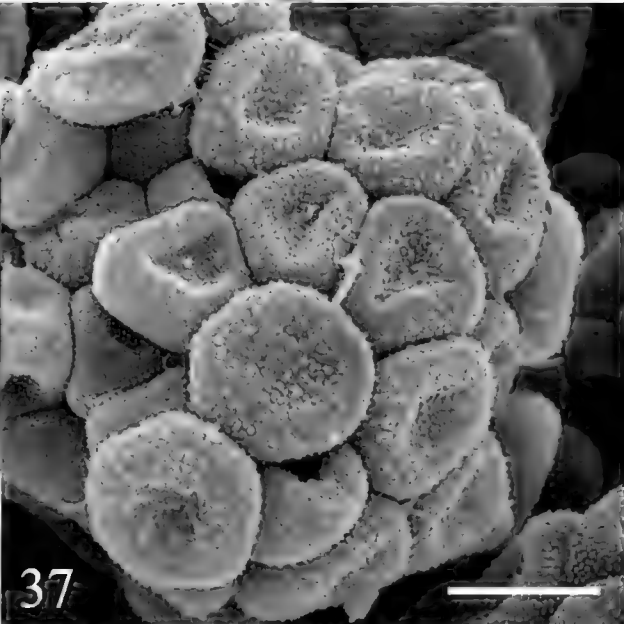
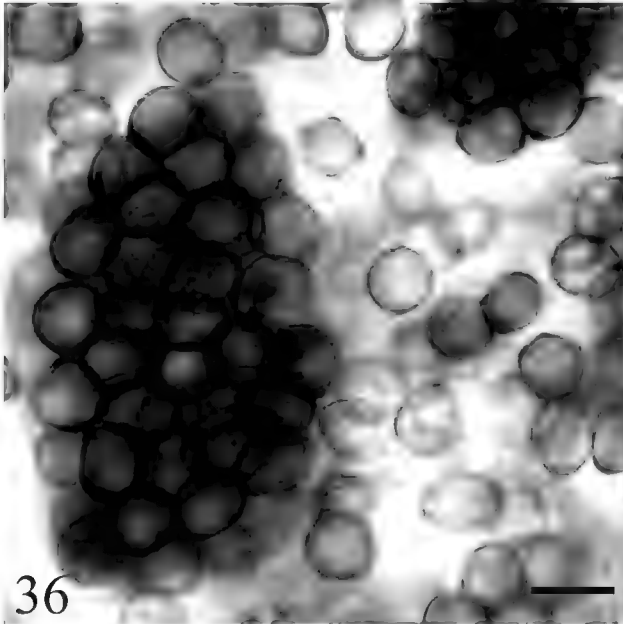
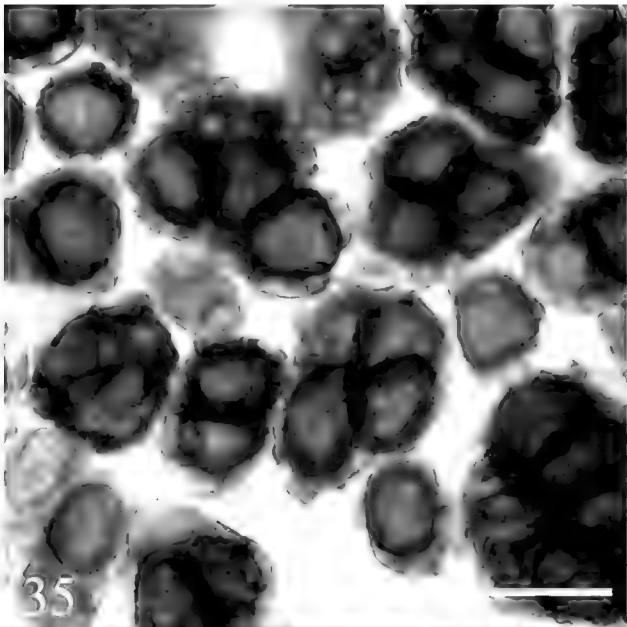
33

from *M. tristachyae* Vánky & C. Vánky 1997 (type on *Tristachya leucothrix* Nees, South Africa) in having larger, paler spores with evenly thinner wall, and in possessing smaller sterile cells. In *M. tristachyae* the spores are more regular, 7–9 µm long, darker (reddish brown), with unevenly 0.5–1.5 µm thick wall, the sterile cells are 16–35 µm long. In addition, the two species infect host plants belonging to different genera. *M. loudetiopsisidis* differs also from *M. simplex* Vánky 2000 (type on *Loudetia simplex*, Zimbabwe), in which the spores are more evidently verruculose, and the sterile cells measure 13–27 × 15–29 µm.

Key to the smut fungi of *Loudetia*, *Loudetiopsis*, *Trichopteryx*, *Tristachya*, and *Zonotriche*

- 1. Sori in the distal part of the stems as long tubes, later as twisted bands 2
- Sori elsewhere 6
- 2. Sori up to 100 cm long; spores densely, prominently echinulate *Mac. ugandensis*
- Sori much shorter; spores finely punctate or verruculose 3
- 3. Spores 7–9 µm long *Mac. tristachyae*
- Spores larger 4
- 4. Spores 8–12 µm long; sterile cells up to 35 µm long *Mac. trichopterygis*
- Spores 9–15 µm long; sterile cells smaller 5
- 5. Spores evidently verruculose; sterile cells up to 29 µm long *Mac. simplex*
- Spores finely punctate-verruculose; sterile cells up to 17 µm long
..... *Mac. loudetiopsisidis*
- 6. Sori on the stems, forming witches' brooms at the nodes *Mac. magicus*
- Sori elsewhere, not forming witches' brooms 7
- 7. Sori comprise the whole inflorescence *Spor. loudetiae-pedicellatae*
- Sori do not comprise the whole inflorescence 8
- 8. Sori comprise the central part of the spikelets, tubular, filiform, later as twisted or looped, 4–6 cm long bands; sterile cells up to 13 µm long *Mac. loudetiae*
- Sori in the ovaries or florets, not as above 9
- 9. Sterile cells present, up to 26–30 µm long; columella, spore balls absent 10
- Sterile cells absent; columella and spore balls, though sometimes evanescent, present 11
- 10. Spores 5–9 µm long; wall of sterile cells 4–7 µm thick *Mac. zonotriches*
- Spores 7–10.5 µm long; wall of sterile cells 1–3 µm thick *Mac. nodiglumis*

FIG. 35. Spore balls, spores and sterile cells of *Urocystis pulsatillae-albae* on *Pulsatilla alba* in LM (type). FIGS. 36–37. Spore balls and spores of *Sporisorium schizachyrii-sanguinei* on *Schizachyrium sanguineum* in LM and in SEM (type). FIGS. 38–39. Spores of *Macalpinomyces loudetiopsisidis* on *Loudetiopsis chrysothrix* in LM and in SEM (type). Bars = 10 µm.



- 11. Columellae more than 8; spore balls evanescent; spores all alike, 6–11 µm long
..... *Spor. catinatum*
- Columellae less than 5; spore balls more or less permanent; spores more or less
dimorphic, larger 12
- 12. Spores 11–22 µm long *Spor. loudetiae-superbae*
- Spores smaller 13
- 13. Spores 12–17 µm long; contact wall of the outer spores thicker (ca 1.5 µm) than
the free wall (ca 1 µm) *Spor. tristachydis*
- Spores smaller; free wall of the outer spores thicker than or equalling the
thickness of the contact walls 14
- 14. Columellae 1–3; spore balls 25–65 µm long *Spor. decorsei*
- Columellae 3–5; spore balls larger 15
- 15. Spore balls 35–90 µm long; free surface of the spores finely verruculose, spore
profile nearly smooth *Spor. tristachyae-hispidae*
- Spore balls 40–110(–140) µm long; free surface of the spores verrucose-
echinulate, spore profile densely serrulate *Spor. tristachyae-nodiglumis*

What is “*Tolyposporium setariicolum* Syd.”?

Sydow & Sydow (1912: 77) published a new smut fungus on *Setaria aurea* from Cameroon, *Tolyposporium setariicola*, giving for it a short description (see below, translated from German). The type in Berlin (B) was lost during World War II. No isotypes could be detected in B, BPI or S.

As species of *Tolyposporium* are restricted to host plants in the *Cyperaceae* and *Juncaceae*, the correct place for this fungus, based on its description, should be in the genus *Sporisorium*. Because of the exisiting name *Sporisorium setariicola* (Bag & Agarwal 2001: 224, as ‘*setaricolum*’), the name *Tolyposporium setariicola* cannot be transferred into the genus *Sporisorium*. It is named:

***Sporisorium sydowiorum* Vánky, nom. nov.**

MYCOBANK MB 514049

≡ *Tolyposporium setariicola* Syd. & P. Syd., Ann. Mycol. 10: 77, 1912 (as ‘*setariicolum*’;
non *Sporisorium setariicola* (Thirum. & Safeeulla) Bag & D.K. Agarwal).

≡ *Tolyposporidium setariicola* (Syd. & P. Syd.) Thirum. & Neerg.,
Friesia 11: 182, 1978 (‘1977’; as ‘*setariicolum*’).

TYPE on *Setaria aurea* (= *S. sphacelata* var. *aurea*), Cameroon, Sidderiberg, 30.VII.1909,
C. Ledermann 4803. Type where(?), not in B (E. Gerhard, pers. comm.).

ETYMOLOGY: This species is named in honour of the German Paul Sydow (1851–1925),
and his son Hans Sydow (1879–1946), two of the “giants of mycology” of the 19th and
20th Centuries, the describers of this smut.

SORI destroying all spikelets of an inflorescence, dark, not swollen. SPORE BALLS globose, ellipsoidal or irregular, 35–70 µm in diam., semipermanent, composed of numerous spores. SPORES subpolyhedrally globose to ellipsoidal, 6–9 × 7–10 µm, brown, covered by easily detaching warts.

On *Poaceae*: *Setaria sphacelata* var. *aurea* (A. Br.) Clayton (*S. aurea* A. Br.); C. Africa (Cameroon). Known only from the type description.

Type not seen, description taken from the original. *Sporisorium sydowiorum* is close to *S. setariicola*, in which the spores, according to the original description, are 8.5–13.5 µm in diameter and verruculose. The easily detaching warts, covering the spores of *Tolyposporium setariicola* (= *Sporisorium sydowiorum*), are an unusual phenomenon within the species of the *Sporisorium/Ustilago* complex, but it is present in a few species of other smut fungus genera, e.g. in *Anthracoidea* and *Exotелиospora*.

Four further *Sporisorium* species are known on *Setaria*: 1. *S. kenyanum* Piątek 2006 (type on *Se. pumila* (Poir.) Roem. & Schult., Kenya), 2. *S. magnusianum* (A.A. Fisch. Waldh.) Vánky 2007 (type on *Se. geniculata* (Lam.) P. Beauv., locality unknown), 3. *S. setariae* (McAlpine) Vánky & R.G. Shivas 2003 (type on *Se. pumila*, Australia), and 4. *S. setariae-mombassanae* (L. Ling) Vánky 2007 (type on *Se. mombassana* R.A.W. Herrm.; = *S. incrassata* (Hochst.) Hack., Malawi). *S. sydowiorum* differs from all these species, as shown in the key below.

Key to the species of *Sporisorium* on *Setaria*

1. Sori in distal part of sterile shoots and leaves, long, twisted *S. kenyanum*
- Sori in ovaries or spikelets, short, not twisted 2
2. Columellae several; spores dimorphic *S. setariae*
- Columella one or absent; spores not dimorphic 3
3. Sori in some ovaries or spikelets of an inflorescence . . *S. setariae-mombassanae*
- Sori in all ovaries or spikelets of an inflorescence 4
4. Spores in semipermanent balls, with easily detaching warts . . . *S. sydowiorum*
- Spores single or in loose balls, punctuate-verruculose to echinulate *S. magnusianum*

New combinations

Ustilago solida has characters of the genus *Tolyposporium*

Berkeley (in Hooker 1860: 270) described *Ustilago solida* Berk. 1860 on ‘*Chaetophora*’ (= *Chaetospora*) *imberbis* (= *Schoenus apogon*), a *Cyperaceae* from Tasmania. The fungus was repeatedly transferred into various genera, e.g. *Urocystis*, *Sorosporium*, *Cintractia*. While members of the genus *Ustilago* are restricted to the *Poaceae*, species of *Sorosporium* (= *Thecaphora*) parasitise dicotyledonous plants only. The genus *Urocystis* is characterised by permanent spore balls composed of spores surrounded by sterile cells. Species of *Cintractia* are parasites of several genera in the *Cyperaceae*, but have single spores, not in balls. Therefore, for this fungus the following name is proposed:

***Tolyposporium solidum* (Berk.) Vánky, comb. nov.**

MYCOBANK MB 512444

BASIONYM: *Ustilago solida* Berk., in Hooker, Flora Tasmaniae 2: 270, 1860.= *Urocystis solida* (Berk.) A.A. Fisch. Waldh., Aperçu Syst. Ustil.: 38, 1877.= *Sorosporium solidum* (Berk.) McAlpine, Smuts of Australia: 185, 1910.= *Cintractia solida* (Berk.) Piepenbr., Nova Hedwigia 70: 310, 2000.TYPE on *Chaetospora* (as '*Chaetophora*') *imberbis* (= *Schoenus apogon*), Australia, Tasmania, Penquite, XII.1845, R.C. Gunn, isotype DAR 59818 (a microscope slide).

SORI in all flowers of an inflorescence, comprising the innermost floral organs, visible between the glumes as black, globose to ovoid bodies, 1–2 mm in diam., exceptionally also on the stems, then fusiform, at first covered by a thick, brown peridium that early flakes away exposing the compact mass of spore balls and spores, powdery on the surface. SPORE BALLS usually irregular or globoid to ellipsoidal, composed of 2–15 spores, loose but rather permanent, $20\text{--}40 \times 25\text{--}55(-70) \mu\text{m}$, reddish brown, developed in a hyaline matrix, in pockets of a sterile stroma. SPORES subglobose, ovoid, elongate or irregular, flattened on one or two sides, $12\text{--}16 \times 15\text{--}20 \mu\text{m}$, yellowish to pale reddish brown; wall uneven, $0.5\text{--}1.5 \mu\text{m}$ thick, smooth to rough, in SEM finely, densely, irregularly verruculose and covered by remnants of the sporogenous hyphae. SPORE GERMINATION unknown.

On *Cyperaceae*: *Schoenus apogon* Roem. & Schult. (*S. brownii* Hook. f.; *Chaetospora imberbis* R. Br.; *S. imberbis* R. Br.), *S. calyptratus* Kük., *S. carsei* Cheeseman, *S. cruentus*, *S. latelaminatus* Kük., *S. maschalinus* Roem. & Schult. (*S. axillaris* (R. Br.) Poir.), *S. nanus* (Lehm.) Benth., *S. nitens* var. *concinus* (Hook. f.) Cheeseman (*S. concinns* (Hook. f.) Hook. f.), *S. pauciflorus* (Hook. f.) Hook. f., *S. tesquorum* J.M. Black, *Schoenus* sp.; Australia, New Zealand.

Doassansia downingiae* is a *Heterodoassansia

The genus *Heterodoassansia* is characterised by a sterile cortex of the spore balls that is composed of two layers, an external one of small, smooth cells and an internal layer of larger, empty cells with ornamented inner surface (comp. Vánky 2002: 76–77).

***Heterodoassansia downingiae* (Liro) Vánky, comb. nov.**

MYCOBANK MB 513231

BASIONYM: *Doassansia downingiae* Liro, Mycotheca fennica. Die Etiketten.

No. 301–600: 114, 1939.

TYPE on *Downingia elegans*, USA, Idaho, Palouse Co., Lake Coeur d'Alene, VI–VII.1892, Aiton. (Type not in BPI, H, HPP, S).

SORI in leaves as minute, amphigenous, indistinct, violet-brown spots, or in stems as up to several cm long swellings with numerous spore balls embedded in the host tissue. SPORE BALLS varying in shape and size, irregularly spherical to cylindrical, $75\text{--}150 \times 75\text{--}200 \mu\text{m}$, brown, composed of a central mass of

spores surrounded by a cortex of sterile cells. SPORES globoid to polyhedral, $7\text{--}10 \times 10\text{--}14\text{ }\mu\text{m}$; wall even, c. $1\text{ }\mu\text{m}$ thick, smooth. CORTICAL STERILE CELLS varying in shape and size, irregularly spherical, obovate or polyhedral, often only $3\text{--}5\text{ }\mu\text{m}$ but sometimes up to $8 \times 10\text{ }\mu\text{m}$ in length, yellowish brown; wall up to $2.5\text{ }\mu\text{m}$ thick, minutely, densely punctuate-echinulate.

On *Campanulaceae*: *Downingia elegans* (Doug.) Torr. (*Bolelia elegans* (Doug.) Greene); N. America. Known only from the type locality.

MATERIAL NOT SEEN. Description taken from the original and Zundel (1953: 226).

Ustilago moelleri is a *Microbotryum*

Microbotryum moelleri (Bref.) Vánky, **comb. nov.**

MYCOBANK MB 513232

BASIONYM: *Ustilago moelleri* Bref., Unters. Gesammtgeb. Mykol.

12: 132, 1895 (as ‘Möller’; on p. 229, Pl. VIII, fig. 4 legend,

‘*Ustilago Polygoni hispidi*’ is a slip of the pen).

= *Sphacelotheca moelleri* (Bref.) Liro, Ann. Acad. Sci. Fenn., Ser. A, 17(1): 158, 1924.

TYPE on *Polygonum hispidum*, Brazil, near Blumenau, 1893, leg. Möller; isotype H!

SORI in fruits, swollen to twice the size of the healthy ones (c. $8\text{--}9\text{ mm}$ long), filled with a dark purplish brown, semi-agglutinated to powdery mass of spores. SPORES solitary, globose, subglobose, broadly ellipsoidal, slightly flattened, rarely irregular, $9\text{--}13.5 \times 10\text{--}15\text{ }\mu\text{m}$, pale yellowish brown with a purplish violet tint; wall evenly $0.8\text{--}2.5(-3)\text{ }\mu\text{m}$ thick, densely verruculose, spore profile finely serrulate, in SEM small, rounded, often slightly elongated warts, with rounded or subacute tip, solitary, or two to several fusing into short rows or irregular groups; disjunctors absent. Spores developing in irregular groups within the hyaline mass of sporogenous hyphae, not catenate. SPORE GERMINATION (Brefeld, 1895, Pl. VIII, fig. 4) without resting period, results in 4-celled basidia, developing broadly ellipsoidal, sessile, conjugating basidiospores, in nutrient media giving rise to yeast colonies.

On *Polygonaceae*: *Polygonum* (sect. *Persicaria*), *P. hispidum* Kunth; S. America. Known only from the type collection.

Seemingly, morphology of the sori and spores of *Microbotryum moelleri* is close to that of *Sphacelotheca hydropiperis*. Liro (1924: 158) studied the type of *Ustilago moelleri*, transferred it into the genus *Sphacelotheca*, and wrote: “Bezüglich des Baues des Sporenbehälters und des Sporenbildes stimmt *Sph. Mölleri* weitgehend mit *Sph. hydropiperis* überein”. (Regarding the structure of the sori and the picture of the spores, *Sph. Mölleri* correspond mainly with *Sph. hydropiperis*). Vánky & Oberwinkler (1994: 26) even considered these two smuts synonyms. However, the spore building of *M. moelleri* differentiates it from *Sphacelotheca*, where the spores develop from hyphae at the base of the sorus, initially catenate, connected by disjunctors, later solitary. The disjunctors,

thickened parts of the exospore on two opposite, usually slightly flattened sides of the spores, are unique and typical for *Sphacelotheca*, but are missing in *M. moelleri*.

Excluded species

Entyloma cyperi is a species of *Physoderma* (*Chytridiomycetes*)

Ahmad (1961: 120) described *Entyloma cyperi* S. Ahmad on the leaves of *Cyperus rotundus* L. from Pakistan, Karachi, 19.V.1956, S. Ahmad 14111.

SORI on leaves forming blackish, epiphyllous, linear or oblong spots, 2–5 mm long or by confluence covering a larger part of the leaf. SPORES embedded in the host tissue, solitary, in irregular groups or in chains, globose, broadly ellipsoidal or with slightly flattened sides, 24–33 μm long, yellowish brown; wall evenly 1–1.5 μm thick, smooth, content homogeneous.

I did not see the type, but by courtesy of Sultan Ahmad (LAH, Lahore), I obtained a specimen, collected by him on the same host plant, in Pakistan, at Zafarwal, on 20.XII.1966 (HUV 17475). Study of this specimen revealed that it is identical with the description of the type, and that it is not a smut fungus but a species of *Physoderma*, *Physodermataceae*.

Ustilago dactylicola is not a smut fungus

Spegazzini (1915: 118) described *Ustilago? dactylicola* Speg. in the fruits of dates (*Phoenix dactylifera* L., *Arecaceae*), from Senegal, Dakar, 19.VI.1913, LPS 3209!, giving a very short description. SORI in the pulp of mature fruits, labyrinthiform, spore mass dark olivaceous, compact. SPORES agglutinated, 10–12 μm in diam., thin-walled. Present are with the normal spores also small, smooth spores of 2 μm diam.

Only spores of *Aspergillus* and chlamydospores are present in the specimen, badly damaged by insects. It is certainly not a smut fungus (Excluded here).

Acknowledgements

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Literature cited

- Ahmad S. 1961 ('1960'). Further contributions to the fungi of West Pakistan, I. *Biologia* (Lahore) 6: 117–136.
- Bag MK, Agarwal DK. 2001. Taxonomic studies on smut fungi from North-Eastern India. *Indian Phytopathol.* 54: 219–225.
- de Bary A. 1874. *Protomyces microsporus* und seine Verwandten. *Bot. Zeitung* (Berlin) 32: 97–108.
- Bauer R, Lutz M, Begerow D, Piątek M, Vánky K, Bacigálová K, Oberwinkler F. 2008. Anther smut fungi on monocots. *Mycol. Res.* 112: 1297–1306.
- Begerow D, Lutz M, Oberwinkler F. 2002. Implications of molecular characters for the phylogeny of the genus *Entyloma*. *Mycol. Res.* 106: 1392–1399.
- Berkeley MJ. 1860. Fungi. In Hooker JD. The botany of the Antarctic voyage, etc., 3, *Flora Tasmaniae*. Vol. 2 Monocotyledones and acotyledones. 1–422 p. + Pls. CXXI–CC. London.
- Brefeld O. 1895. Untersuchungen aus dem Gesamtgebiete der Mykologie. XII. Hemibasidii. Brandpilze III. Münster i. W., Commissions-Verlag v. H. Schöningh. IV + 99–236 pp. + Pls. VI–XII.
- Ershad D. 2000. *Vankya*, a new genus of smut fungi. *Rostaniha* 1: 65–72 (in English), 151–161 (in Farsi, and Figs. 1–6).
- Fischer von Waldheim AA. 1867. Sur la structure des spores des Ustilaginées. *Bull. Soc. Imp. Naturalistes Moscou* 40: 242–261.
- Fischer von Waldheim AA. 1877. Aperçu systématique des Ustilaginées, leurs plantes nourricières et la localisation de leurs spores. Paris, Lahure, 51 pp.
- Husz B. 1921. Adatok a Magas-Tátra és a Szepesség mikroszkopikus gombaflórájának ismeretéhez (Data to the knowledge of the microfungus flora of the High Tatra and Szepesség; In Hungarian) *Bot. Közlem.* 19: 96–105.
- Liro JI. 1924. Die Ustilagineen Finnlands I. *Ann. Acad. Sci. Fenn.*, Ser. A, 17(1): 1–636.
- Liro JI. 1939. Mycotheca fennica. Die Etiketten. No. 301–600. Helsinki, 136 pp.
- McAlpine D. 1910. The Smuts of Australia. Their structure, life history, treatment, and classification. Melbourne, 285 pp.
- Moesz G. 1950. A Kárpát-medence üszöggombái. (Les *Ustilaginales* du Bassin des Carpathes). Budapest, Egyetemi Könyvkiadó, 256 pp.
- Piepenbring M. 2000. The species of *Cintractia* s. l. (*Ustilaginales*, *Basidiomycota*). *Nova Hedwigia* 70: 289–372.
- Piepenbring M. 2002. Diversity, taxonomy, and ecology of plant parasitic smut fungi in Bolivia. *Ecol. Bolivia* 37: 49–58.
- Rüegg J. 1990. Le chardon bleu cultivé comme fleur à couper. *Rev. Suisse Vitic. Arboric. Hort.* 22: 385–392.
- Servazzi O. 1950. Sur un *Entyloma* (sp. n.?) di *Eryngium alpinum* L. *Nuovo Giorn. Bot. Ital.* 57: 306–308.
- Spegazzini C. 1915. Fungi nonnulli senegalenses et canarienses. *Anales Mus. Nac. Hist. Nat. Buenos Aires* 26: 117–134.
- Sydow H, Sydow P. 1912. Novae fungorum species. VII. *Ann. Mycol.* 10: 77–85.
- Thirumalachar MJ, Neergaard P. 1978('1977'). Studies on the genus *Tolyposporium*. *Tolyposporidium* gen. nov. *Friesia* 11: 177–192.
- Vánky K. 1994. European smut fungi. Gustav Fischer Verlag, Stuttgart, Jena, New York.
- Vánky K. 1997. Taxonomical studies on *Ustilaginales*. XVII. *Mycotaxon* 65: 159–182.

Vánky K. 2002. Illustrated genera of smut fungi. 2nd. Ed. APS Press, 238 pp.

Vánky K. (in press). Smut fungi of the world. APS Press, St. Paul, Minnesota.

Vánky K, Oberwinkler F. 1994. The smut fungi of *Polygonaceae*, a taxonomic revision. Beih. Nova Hedwigia 107: 1–96.

Vánky K, Shivas RG. 2003. Further new smut fungi (*Ustilaginomycetes*) from Australia. Fungal Diversity 14: 243–264.

Vánky K, Shivas RG. 2008. Fungi of Australia. The smut fungi. CSIRO Publishing, 276 pp. + CD, also by Beasley D.

Zundel GL. 1953. The *Ustilaginales* of the world. Contr. Dept. Bot. School Agric. Pennsylvania State Coll. 176: XI + 1–410.

First record of *Mattirolomyces terfezioides* from the Iberian Peninsula: its southern- and westernmost locality

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The paper honors the 150th anniversary of
the birth of LÁSZLÓ HOLLÓS (1859–1940).

Abstract — During revision of *Terfezia* specimens in the Mycological Collection of the Herbarium of the Real Jardín Botánico of Madrid (MA-Fungi), morphological and molecular analyses revealed a specimen collected in Madrid as the truffle *Mattirolomyces terfezioides*. This paper presents the first record of the species from the Iberian Peninsula, the western- and southernmost known locality for *M. terfezioides* in Europe. General characteristics of known collection sites are also discussed.

Key words — *Pezizaceae*, *Hydnobolites*, biogeography, host plant, ITS

Introduction

The truffle *Mattirolomyces terfezioides* (Mattir) E. Fisch. 1938 was described as *Choiromyces terfezioides* by Mattirol based on a northern Italian collection from Piemonte (Mattirol 1887). Fischer (1938) determined that it represented a distinct genus, which he named *Mattirolomyces* for “the Mattirol fungus.” Trappe (1971) placed *Mattirolomyces* into the desert-truffle genus *Terfezia* but changed its rank to a subgenus. Subsequent molecular phylogenetic analyses unambiguously show that *Mattirolomyces* merits generic status (Percudani et al. 1999, Díez et al. 2002, Læssøe & Hansen 2007) within the *Pezizaceae*, lineage A (Læssøe & Hansen 2007, Trappe et al. 2009). Originally the genus was monotypic and represented only by *M. terfezioides*. Healy (2003) later described a new species, *M. tiffanyae* Healy, but according to molecular phylogenetic analyses it does not belong to *Mattirolomyces* (Hansen, Healy & Kovács, unpublished data). However, a more recent study on Australian and

Kalahari desert truffles has revealed two other *Mattirolomyces* species (Trappe et al. 2009), and one more is being described from North America and Asia (Kovács, Alsheikh & Trappe, unpublished data). These recent findings establish the genus *Mattirolomyces* as more diverse taxonomically and more widely distributed than previously thought.

Mattirolomyces terfezioides was described with a collection from Testona, Moncalieri-Piemonte, Italy as the holotype. The species was subsequently collected in other North Italian localities (Montecchi & Sarasini 2000). The species has been recorded from Provence, 18 km east of Avignon in Southern France (OSC Trappe 4548, Alsheikh 1994) as well as from the northern Balkan Peninsula (Ławrynowicz et al. 1997). The first record of the species from Hungary was in 1915 (Hollós 1933); most Hungarian collections are from mixed black-locust (*Robinia pseudoacacia*) forests on sandy soils (Szemere 1965, Babos 1981, Király et al. 1992, Király & Bratek 1992, Kovács & Bagi 2001, Kovács et al. 2001, 2007).

During comparative studies of *Terfezia* species in the Mycological Collection of the Herbarium of the Real Jardín Botánico, Madrid (MA-Fungi), a possibly mis-identified specimen was found among the *Terfezia* specimens. Our main aim in this paper is to present the morphological features and molecular taxonomic results that reveal it as the first record of *M. terfezioides* from the Iberian Peninsula. General characteristics of the habitats of the species are also discussed.

Materials and methods

Microscopy

The light microscopic characterization of the dry specimen was carried out by studying hand made sections of the ascoma after rehydration in 5% KOH. Spores and ascus sizes were measured with an ocular-micrometer. Micrographs were obtained using Nomarski (differential interference contrast) optics of a Nikon 80i microscope equipped with digital camera. Ascospores were studied by scanning electron microscopy with a Hitachi S-3000N SEM (Madrid, RJB) after gold coating of the samples.

Molecular identification

A small piece (~ 15 mg) of the dry ascoma was used to extract total genomic DNA with an E.Z.N.A. Fungal DNA Extraction kit (Omega) following the manufacturer's instructions with small modifications. The ITS region of the nrDNA was amplified and sequenced as detailed by Martín & Winka (2000). The electrophoregrams were checked and assembled by use of the Staden Program Package (Staden et al. 2000). BLASTn (Altshul et al. 1990) was used to compare our sequences with nuclear sequences deposited in public databases. Our ITS sequence has been deposited in GenBank (GQ422438).

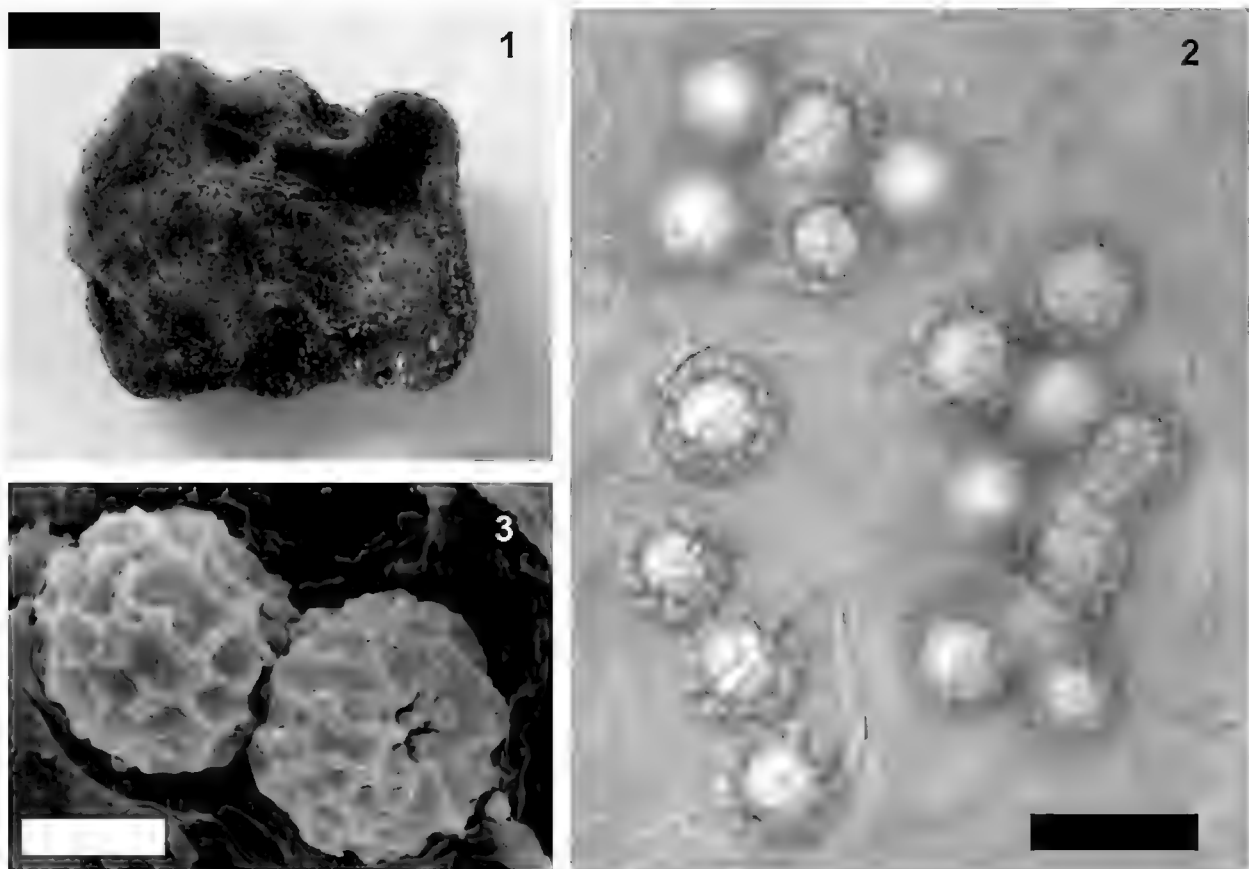


FIG. 1. The slice of the small ascoma of *Mattirolomyces terfezioides* in the herbarium specimen MA-Fungi 8212 collected in Madrid, Spain. Bar = 5 mm. FIG. 2. Light microscopy of ascospores of *M. terfezioides* (MA-Fungi 8212). Bar = 20 μ m. FIG. 3. Scanning electron micrograph of ascospores of MA-Fungi 8212. Bar = 10 μ m.

Results and discussion

Specimen MA-Fungi 8212 was collected in Madrid city (in “Colonia del Retiro”) on 30 August 1984 and deposited in the herbarium as *Terfezia claveryi* Chatin 1892. A penciled note with the specimen states (translated from Spanish): “Obs. it has reticulate spores”. In 1990 the specimen was studied again and still marked as *Terfezia claveryi*. During a further study in 2001, the specimen was marked as *Hydnobolites cerebriformis* Tul. & C. Tul. 1843. No further information either about the locality or the environment was recorded with the specimen.

MA-Fungi 8212 contains a relatively thick slice of a small ascoma (FIG 1). The material was in poor condition: one side of the slice was moldy. The organization of the gleba was hardly visible, and no distinct peridium could be detected even in the microscope slides: only crushed, broken cells could be seen. Most asci were broken, but spores were clustered in groups of eight. Spores were relatively small, 15–18 μ m broad (ornamentation included) and reticulate (FIGS 2 and 3), and several were broken. The anatomical features of the specimen fit the known characteristics of *M. terfezioides* (Szemere 1965,

Alsheikh 1994). Nevertheless, due to the poor development and condition of the specimen and its geographic origin (see below), one could easily think that one of the two truffle species written on the capsule was found.

The ITS sequence of the specimen was identical with *M. terfezioides* ITS sequences deposited in GenBank. The previously sequenced nrDNA ITS region of the *M. terfezioides* collected in Provence, France (GQ231754, Trappe et al. 2009), was also identical with *M. terfezioides* GenBank sequences and that of the Madrid specimen. Almost no variation was found between the nrDNA ITS sequences of *M. terfezioides* from various localities in Hungary and Italy (Kovács et al. 2001). This invariability enabled the design of species-specific PCR primers used to identify the natural hosts of *M. terfezioides* (Kovács et al. 2007).

Although most *M. terfezioides* records are from mixed *Robinia pseudoacacia* forests on sandy soils in the Danube basin, the urban environment of the Madrid collection is not unique for the species. The first documented collection of the fungus in Hungary by László Hollós was in a cemetery of Szekszárd “below an old black-locust tree at a weakly grassed almost bare place” on 27 July 1915 (Hollós 1933). This was the first published record of the fungus since the species was originally described from Piemonte. Babos (1981) reported herbarium specimens collected within Budapest on sandy soils, even in a cemetery, with *Robinia* and other trees, and she also noted a collection from a village garden close to Budapest. One of us (G.M. Kovács) also collected the fungus in a cemetery in the small village Felsőszentiván, close to the Southern border of Hungary in early November 2004. Montecchi & Sarasini (2000) also reported various cultivated environments (e.g., *Ficus* stumps, asparagus market garden) as *M. terfezioides* habitats – similar to Mattiolo (1887) who mentioned that people regularly collected *M. terfezioides* during cultivation.

In light of these data, it is not odd that *M. terfezioides* was collected in Madrid in the “Colonia del Retiro” district. Unfortunately no information was recorded about the soil in which it was found or the plants that surrounded it. In view of the collections listed above and further details surrounding the biotic environments of the known host plants (Kovács et al. 2007), we infer that *M. terfezioides* has no specific host.

Until now the westernmost known locality of *M. terfezioides* has been southern France. Its easternmost known locality is in Hungary. Madrid, at 40°24' N and 3°41' W, represents the most western and southern known locality of the species. Moreover, this is the first record of *M. terfezioides* from the Iberian Peninsula. As the hypogeous fungi of Spain have been widely studied and both the harvesting and the cultivation of truffles and desert truffles have a long tradition (Moreno et al. 1986, 1991; Honrubia et al. 1992; Alvarez et al. 1993; Moreno-Arroyo et al. 1999, 2005; Calonge et al. 1999, 2000; Díez et al.

2002; Morte et al. 2008), we might assume that the species might be rare in the area. Nevertheless, one should bear in mind the unsuspected geographic presence of *M. terfezioides* and its similarities with other hypogeous fungal species, especially when poorly developed or degraded ascomata are found: the species might be overlooked and/or misidentified as happened in the case of MA-Fungi 8212.

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References

- Alsheikh AM. 1994. Taxonomy and mycorrhizal ecology of the desert truffles in the genus *Terfezia*. PhD Diss, Oregon State University, Corvallis.
- Altschul SF, Gish W, Miller W, Myers EW, Lipman DJ. 1990. Basic local alignment search tool. *J. Mol. Biol.* 215: 403–410.
- Alvarez IF, Parlade J, Trappe JM, Castellano MA. 1993. Hypogeous mycorrhizal fungi of Spain. *Mycotaxon* 47: 201–217.
- Babos M. 1981. Distribution of *Choiromyces venosus* and *Terfezia terfezioides* in Hungary. (in Hungarian with English summary) *Mikol. Közl.* 20(1–2): 47–56.
- Calonge FD, Vasco F, Fernández A. 1999 Contribución al conocimiento de los hongos hipogeos de Albacete, España. *Bol. Soc. Micol. Madrid* 24: 187–191.
- Calonge FD, Fernández A, Vasco F. 2000. Contribución al conocimiento de los hongos hipogeos de Albacete (España). II. Registro de 10 especies nuevas para la provincia. *Bol. Soc. Micol. Madrid* 25: 171–176.
- Díez J, Manjón JL, Martín F. 2002. Molecular phylogeny of the mycorrhizal desert truffles (*Terfezia* and *Tirmania*), host specificity and edaphic tolerance. *Mycologia* 94: 247–259.
- Fischer E. 1938. Klasse *Ascomycetes*, Reihe *Euascales*. Unterreihe VIII. *Tuberineae*. In: Engler A, Harms H (eds), *Natürlichen Pflanzenfamilien V*. Wilhelm Engelmann Verlag, Leipzig, p 39
- Healy RA. 2003. *Mattirolomyces tiffanyae*, a new truffle from Iowa, with ultrastructural evidence for its classification in the Pezizaceae. *Mycologia* 95: 765–772.
- Hollós L. 1933. Szekszárd vidékének gombái (Fungi regionis Szekszárdiensis). (in Hungarian) *Math. Term. Tud. Közl.* 37(2): 1–205.
- Honrubia M, Cano A, Molina-Niñirola C. 1992. Hypogeous fungi from southern Spanish semiarid lands. *Persoonia* 14: 647–653.
- Király I, Bratek Z. 1992. *Terfezia terfezioides* a common truffle in Hungary. *Micol. Veg. Med.* 7: 43–45.
- Király I, Bratek Z, Albert L, Lukács Z. 1992. The arenicolous truffle (*Terfezia terfezioides*). (in Hungarian with English summary) *Mikol. Közl.* 31(1–2): 49–54.

- Kovács GM, Bagi I. 2001. Mycorrhizal status of a mixed deciduous forest from the Great Hungarian Plain with special emphasis on the potential mycorrhizal partners of *Terfezia terfezioides* (Matt.) Trappe. *Phyton* 41: 161–168.
- Kovács GM, Rudnóy S, Vágvölgyi C, Lásztity D, Rácz I, Bratek Z. 2001. Intraspecific invariability of the internal transcribed spacer region of rDNA of the truffle *Terfezia terfezioides* in Europe. *Folia Microbiol.* 46: 423–426.
- Kovács GM, Jakucs E, Bagi I. 2007. Identification of host plants and description of sclerotia of the truffle *Mattirolomyces terfezioides*. *Mycol. Progress* 6: 19–26.
- Læssøe T, Hansen K. 2007. Truffle trouble: what happened to the *Tuberales*? *Mycol. Res.* 111: 1075–1099.
- Ławrynowicz M, Marković M, Milenković M, Ivančević B. 1997. *Terfezia terfezioides* – a new hypogeous fungus for Balkan Peninsula. *Acta Mycol.* 32: 233–238.
- Mattiolo O. 1887. Illustrazione di tre nuove specie di Tuberacee Italiane. *Mem. della Reale Accad. Sci. Torino (Seconda serie)* 38: 377–393.
- Martín MP, Winka K. 2000. Alternative methods of extracting and amplifying DNA from lichens. *Lichenologist* 32: 189–196.
- Montecchi A, Sarasini M. 2000. *Funghi Ipogei d'Europa*. Associazione Micologica Bresadola, Fondazione Centro Studi Micologici, Trento.
- Moreno G, Galan R, Ortega A. 1986. Hypogeous fungi from continental Spain. 1. *Crypt. Mycol.* 7: 201–229.
- Moreno G, Galan R, Ortega A. 1991. Hypogeous fungi from peninsular Spain. 2. *Mycotaxon* 42: 201–238.
- Moreno-Arroyo B, Calonge FD, Gómez J, Pulido E. 1999. Flora micológica hipogea de Andalucía (España). *Bol. Soc. Micol. Madrid* 24: 127–178.
- Moreno-Arroyo B, Gómez J, Pulido E. 2005. *Tesoros de nuestro montes. Trufas de Andalucía*. Consejería de Media Ambiente, Junta de Andalucía, Córdoba, Spain.
- Morte A, Honrubia M, Gutiérrez A. 2008. Biotechnology and cultivation of desert truffles. In: Varma A (ed.) *Mycorrhiza, State of the Art, Genetics and Molecular Biology, Eco-Function, Biotechnology, Eco-Physiology, Structure and Systematics*. Springer-Verlag, Berlin, Heidelberg, pp: 467–483.
- Percudani R, Trevisi A, Zambonelli A, Ottonello S. 1999. Molecular phylogeny of truffles (*Pezizales: Terfeziaceae, Tuberaceae*) derived from nuclear rDNA sequence analysis. *Mol. Phyl. Evol.* 13: 169–180.
- Staden R, Beal KF, Bonfield JK. 2000. The Staden package, 1998. *Methods Mol. Biol.* 132: 115–130.
- Szemere L. 1965. *Die unterirdischen Pilze des Karpatenbeckens (Fungi hypogaei territorii Carpato-Pannonici)*. Akadémiai Kiadó, Budapest, Hungary.
- Trappe JM. 1971. A synopsis of the *Carbomycetaceae* and *Terfeziaceae* (*Tuberales*). *Trans. Brit. Mycol. Soc.* 57: 85–92.
- Trappe JM, Kovács GM, Claridge AW. (2010, in press). Comparative taxonomy of desert truffles of the Australian Outback and African Kalahari. *Mycol. Progress*.

A phylogeny of *Cribrariaceae* among *Myxomycetes* derived from morphological characters

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Abstract – A cladistic study of the *Cribrariaceae* was performed to examine its phylogenetic position among the *Myxomycetes* based on a data matrix comprising 54 morphological characters and 55 exemplar myxomycete species. Parsimony ratchet with implied weighting was employed as tree search strategy. Results show the *Cribrariaceae* as a monophyletic group that includes *Cribraria* and *Dictydium* but not *Lindbladia* and suggest *Trichiales* as the sister group. Our analyses neither support *Dictydium* as a genus separated from *Cribraria* nor the *Liceales* as monophyletic. This is the first attempt to evaluate the phylogenetic relationships of this group using morphological characters from representative species of all *Myxomycetes* within a cladistic framework.

Keywords – *Echinosteliales*, *Physarales*, slime molds, *Stemonitales*, taxonomy

Introduction

According to Alexopoulos (1973), Zopf (in *Die Pilzthiere oder Schleimpilze*, 1885) included *Cribrariaceae* within the *Endosporeae* in the division *Eumycetozoa* based on the presence of swarm cells, true plasmodia, and the formation of spores in sporocysts. Massee (1892), who based his classification on the capillitium as the primary taxonomic criterion, divided the *Myxogastres* into four orders, placing *Cribrariaceae* in order *Peritricheae* suborder *Cribrariae* together with the suborder *Tubulinae*. In contrast, Lister (1894), using spore color as primary criterion and presence/absence of lime and capillitial structure as secondary criteria, included the *Cribrariaceae* within Sub-class II *Endosporeae* in the Cohort II-*Lamprosporaes* (spores not violet brown) and Sub-cohort I *Anemineae* (no capillitium). Macbride & Martin (1934) divided the *Myxomycetes* into four orders: *Physarales*, *Stemonitales*,

Trichiales and *Liceales*, placing the *Cribrariaceae* in the *Liceales*. Most modern authors (Martin et al. 1983, Nannenga-Bremekamp 1991, Stephenson & Stempen 1994, Lado & Pando 1997, Keller & Braun 1999) include six orders (*Ceratiomyxales*, *Echinosteliales*, *Physarales*, *Stemonitales*, *Trichiales*, *Liceales*) in the *Myxomycetes*, although *Ceratiomyxales* are currently recognized as most closely related to the protostelids (Olive 1975, Spiegel 1990, Spiegel et al. 1995). *Cribrariaceae* is classified together with *Liceaceae* and *Reticulariaceae* in Subclass *Myxogastromycetidae* in *Liceales* (Martin 1960, Martin & Alexopoulos 1969).

The order *Liceales* is traditionally characterized mainly by the absence of a true capillitium (Eliasson 1977). The *Cribrariaceae* was established in 1838 (Hawksworth et al. 1995) to accommodate species possessing: *i*) a netlike covering that extends over either the entire surface of the fruiting body spore mass or upper sporotheca and *ii*) the presence of minute conspicuous granules. Although we refer to the latter as “plasmodic granules” (Lister 1911, 1925) based on their plasmodic origin, these are also known as “dictydine granules” (Martin 1949, Martin & Alexopoulos 1969) or “lime globules” (Nannenga-Bremekamp 1991). Schoknecht (1975) revealed the presence of calcium in the plasmodic granules, but their chemical structure is still unknown. At present, the netlike covering and plasmodic granules are diagnostic for the *Cribrariaceae*, even though *Lindbladia tubulina*, *Cribraria zonatispora* (Lado et al. 1999), and *C. fragilis* (Estrada-Torres et al. 2001) lack a peridial net. All species in this family (with a few exceptions, such as *Lindbladia tubulina*) also produce stalked sporangia as fruiting bodies.

The *Cribrariaceae* can include either two (*Cribraria*, *Lindbladia*) or three (*Cribraria*, *Dictydium*, *Lindbladia*) genera. For example, North American researchers following Lister (1925) recognize *Dictydium* as a separate genus (Martin 1949, Martin & Alexopoulos 1969, Farr 1976, Stephenson & Stempen 1994, Keller & Braun 1999), while most Europeans include *Dictydium* within *Cribraria* (Eliasson 1977, Nannenga-Bremekamp 1991, Lado & Pando 1997). Both taxonomic schools include *Lindbladia* in the *Cribrariaceae*. *Lindbladia tubulina*, which has been referred to other genera — *Aethalium*, *Enteridium*, *Licea*, *Perichaena*, *Physarum*, *Tubulina* (Martin & Alexopoulos 1969) — is a variable taxon that forms true aethalia at one extreme but intergrades into pseudoaethalia; sporangia vary from closely spaced to (usually) sessile or (rarely) short-stalked (Hatano et al. 1996). Although *Lindbladia tubulina* has no peridial network, the presence of plasmodic granules maintains its placement in the *Cribrariaceae* (Martin & Alexopoulos 1969). Until now, there has been no phylogenetic study to evaluate either the monophyly of the *Liceales* or the relationships among genera of *Cribrariaceae* and with other groups of *Myxomycetes*. Schoknecht (1975) suggested that the presence of calcium in

the plasmodic granules might indicate a possible relationship between the *Cribrariaceae* and the *Physaraceae*, but there has been no study to demonstrate this relationship in a phylogenetic context. The main goal in this paper is to use cladistics analysis of morphological characters to evaluate which genera belong to the *Cribrariaceae* and to explore the phylogenetic position of *Cribrariaceae* among *Myxomycetes*.

Materials and methods

Choice of terminal units

Representative species of all *Myxomycetes* were included in this study. We selected a total of 55 exemplar species representing each order and family as classified in Martin et al. (1983) for which complete specimens permitted observation of all characters. Terminal units comprised 5 *Trichiales*, 6 *Stemonitales*, 8 *Physarales*, and 4 *Echinosteliales*. Of the *Liceales*, 17 species represented *Cribrariaceae*, 7 *Liceaceae*, and 6 *Reticulariaceae*. We also selected as outgroups two species of *Ceratiomyxales*, an order currently phylogenetically placed in the protostelids (Olive 1975, Spiegel 1990, Spiegel et al. 1995). Taxonomic names follow Hernández-Crespo & Lado (2005). All specimens studied belong to the herbarium TLXM at the Universidad Autónoma de Tlaxcala (see TABLE 1).

TABLE 1. List of specimens examined

ORDER	TERMINAL UNITS AND REPRESENTATIVE SPECIMENS
<i>Ceratiomyxales</i>	<i>Ceratiomyxa fruticulosa</i> (O.F. Müll.) T. Macbr. ET-4676, ET-2536, RP-2672, S. L. Stephenson-7405
	<i>Ceratiomyxa morchella</i> A.L. Welden ET-3419, ET-3602
<i>Trichiales</i>	<i>Calomyxa metallica</i> (Berk.) Nieuwl. RP-1566, GF-1134
	<i>Calonema foliicola</i> Estrada et al. ET-8159, ET-8286, ET-4532
	<i>Hemitrichia calyculata</i> (Speg.) M.L. Farr RP -2582, ET-4081b, ET-4220
	<i>Metatrichia vesparia</i> (Batsch) Nann.-Bremek. RP-2361, ET-4520
	<i>Trichia decipiens</i> (Pers.) T. Macbr. HC-718, MAFungi-27069, S. L. Stephenson-7406
<i>Stemonitales</i>	<i>Comatricha laxa</i> Rostaf. VG-580, HC-1384, HC-1582, RP-1559
	<i>Enerthenema papillatum</i> (Pers.) Rostaf. RP-35, GF-203, MAFungi-17206
	<i>Lamproderma scintillans</i> (Berk & Broome.) Morgan ET-4612a, RP-1076, RP-251
	<i>Stemonaria longa</i> (Peck) Nann.-Bremek. et al. RP-2149, ET-6037
	<i>Stemonitis pallida</i> Wingate ET-10308, ET-4470
	<i>Stemonitopsis typhina</i> (F.H. Wigg.) Nann.-Bremek. RP-2197a, ET-4250, ET-4901, ET-4401
<i>Physarales</i>	<i>Diachea leucopodia</i> (Bull.) Rostaf. ET-4734, RP-2603, ET-4393
	<i>Didymium serpula</i> Fr. RP-1782
	<i>Elaeomyxa cerifera</i> (G. Lister) Hagelst. HC-1706, GF-826
	<i>Lepidoderma tigrinum</i> (Schrad.) Rostaf. HC-1521, HC-1700, HC-2302
	<i>Physarella oblonga</i> (Berk. & M.A. Curtis) Morgan ET-5030, RP-2525, ET-4615, ET-4960
	<i>Physarum bogoriense</i> Racib. ET-4617, ET-10514, ET-4301a
	<i>Physarum flavicomum</i> Berk. ET-6080
	<i>Willkommllangea reticulata</i> (Alb. & Schwein.) Kuntze ET-3590
<i>Liceales</i>	<i>Cribraria argillacea</i> (Pers. ex J.F. Gmel.) Pers. GF-535, GF-365, RP-1999
	<i>Cribraria atrofusca</i> G.W. Martin & Lovejoy HC-870, GF-728, GF-940
	<i>Cribraria aurantiaca</i> Schrad. TNS-2612
	<i>Cribraria cancellata</i> (Batsch) Nann.-Bremek. RP-2199a
	<i>Cribraria fragilis</i> Lado & Estrada E. Conde-pw17

TABLE 1, CONCLUDED

	<i>Cribraria microcarpa</i> (Schrad.) Pers. TNS-3445
	<i>Cribraria mirabilis</i> (Rostaf.) Massee GF-44, MAFungi-17473
	<i>Cribraria oregana</i> H.C. Gilbert RP-1868, RP-1100, HC-183
	<i>Cribraria piriformis</i> Schrad. HC-2285, RP-1523, RP-227, MAFungi-27001
	<i>Cribraria purpurea</i> Schrad. HC-1589, HC-815, HC-171, HC-497, HC-892, HC-1869
	<i>Cribraria rufa</i> (Roth) Rostaf. MAFungi-27121
	<i>Cribraria splendens</i> (Schrad.) Pers. GF-1769, GF-396, HC-110
	<i>Cribraria tenella</i> Schrad. ET-4448, ET-4307, ET-4229
	<i>Cribraria violacea</i> Rex ET-4740b, ET-4863, RP-2147
	<i>Cribraria vulgaris</i> Schrad. GF-1356, HC-2031, HC-2075, GF-1772
	<i>Cribraria zonatispora</i> Lado et al. E. Conde-pm56
	<i>Dictydiaethalium plumbeum</i> (Schumach.) Rostaf. ET-3562
	<i>Licea biforis</i> Morgan EC- p55, S. L. Stephenson-7422
	<i>Licea castanea</i> G. Lister VG-346, VG-561, VG-471, VG-726
	<i>Licea minima</i> Fr. Vázquez-García 2, MAFungi-27131
	<i>Licea parasitica</i> (Zukal) G.W. Martin HC-2006, VG-444, VG-462
	<i>Licea pusilla</i> Schrad. RP-1058, RP-179, GF-417
	<i>Licea pygmaea</i> (Meyl.) Ing RP-2017, HC-232, HC-783, VG-343
	<i>Licea variabilis</i> Schrad. RP-2300
	<i>Lindbladia tubulina</i> Fr. GF-769, RP-195
	<i>Lycogala conicum</i> Pers. Autun-71
	<i>Lycogala epidendrum</i> (L.) Fr. RP-1458, GF-218, MAFungi-20556, S. L. Stephenson-7412
	<i>Reticularia olivacea</i> (Ehrenb.) Fr. RP-978, MAFungi-17202
	<i>Reticularia splendens</i> Morgan RP-743, GF-896
	<i>Tubulifera arachnoidea</i> Jacq. RP-542, GF-148, MAFungi-17468, 17401, S. L. Stephenson-7416
<i>Echinosteliales</i>	<i>Clastoderma debaryanum</i> A. Blytt ET-6328
	<i>Clastoderma pachypus</i> Nann.-Bremek. ET-5378
	<i>Echinostelium arboreum</i> H.W. Keller & T.E. Brooks GF-256
	<i>Echinostelium minutum</i> de Bary ET-892

Morphological data matrix

Characters were selected and analyzed based on the variation observed among species and previous reports in the literature, without excluding a priori any source of information. Morphological observations were analyzed and interpreted in the framework of cladistic epistemology (De Pinna 1991, De Luna & Mishler 1996). Hypotheses of homology were based on similarity, conjunction, independence, variability, and heritability as the principal criteria proposed by De Pinna (1991). Empirical delimitation of characters and states should be considered our best estimates and potentially subject to modification and rejection, as it should be for all characters in any cladistic analysis.

Variable morphological characters were scored into at least two states (see APPENDIX 2). Characters often used to classify *Myxomycetes* (Martin & Alexopoulos 1969) included sporotheca features (e.g., sporocarp morphology, capillitial type, sporophore arrangement, spore ornamentation, type of lime in the peridium, presence of plasmodic granules, surface net, color of spores and capillitium). Potentially useful characters still unknown for most species (e.g., plasmodium, swarm cells ultrastructure) were excluded. Of the selected morphological characters, 46 were binary coded and 8 were multi-state (APPENDIX 2). The data matrix comprising 55 terminal units and 54 characters was constructed in MacClade 4.05 (Maddison & Maddison 2002) (see APPENDIX 1). Multi-

state characters were kept unordered. Characters with more than one state in a single terminal unit were coded as polymorphic.

Phylogenetic analyses

All characters were initially weighted equally (EW analyses). We used PAUPRat (Sikes & Lewis 2001) to implement a parsimony ratchet search using PAUP 4.0B10 (Swofford 2000) on a Macintosh G4 iBook. The parsimony ratchet is efficient at finding trees for data sets too large for traditional heuristic search methods (Nixon 1999). Following author recommendations, we performed several searches, creating multiple folders (=20), each with a separate batch file, with 200 iterations perturbing just 10% of the characters (Goloboff 1997). Trees from each search were collected into a single file and filtered. A strict consensus was calculated on these EW final trees.

Character states were optimized with the ACCTRAN option on a tree selected by an additional search with implied weighting in PAUP 4.0b10. Jackknife values (Farris et al. 1996) and Bremer index (Bremer 1994) measured the relative support of clades. Jackknife values were estimated with 10% of the characters deleted using the “fast” stepwise-addition option and repeated 10 times with 10000 replicates in PAUP. Bremer values were generated using Auto Decay version 4.0.2 (Eriksson 1999) over PAUP.

Implied weighting

Farris (1983) noted that because not all characters provide equal phylogenetic information, some characters deserve more weight than others. We used implied weighting (IW) to assess the effects of weighting against homoplastic characters. This weighting scheme uses evidence on homoplasy to estimate character reliability (Goloboff 1997). A character that operates as an uncontroversial synapomorphy (no reversals, no parallelism, therefore no homoplasy) will have a CI (consistency index) or RI (retention index) of 1.0, whereas a character with some homoplasy will have lower fit (Wenzel 2002). The IW was calculated in PAUP 4.0b10, holding 100 trees in each replicate. Instead of minimizing the length of a cladogram during the search of the most parsimonious tree, the value to be maximized under the implied weighting procedure is the FIT or the sum of the FIT of each individual character in a given tree. The FIT was determined by a decreasing concave function that accounts for the homoplasy (i.e. extra steps) of a character i in the tree under evaluation, and a constant, K , that defines the concavity of the function (Goloboff 1993). The concavity of the function is steeper at lower values of K and so penalizes more strictly the homoplastic characters. At higher values of K , the function becomes asymptotically similar to the linear function of equal weights. So far, the decision concerning on how strongly to weight against homoplasy has been subjective (Lopardo 2005). We performed several analyses under different concavity values until the tree did not change further. We found the best-FIT character with a $K=20$ value.

Results

Phylogenetic analyses

The EW analyses produced 875 equally most parsimonious trees after filtering, each 167 steps long and with a consistency index (CI) of 0.461 and retention index (RI) of 0.728. The EW strict consensus tree was unresolved

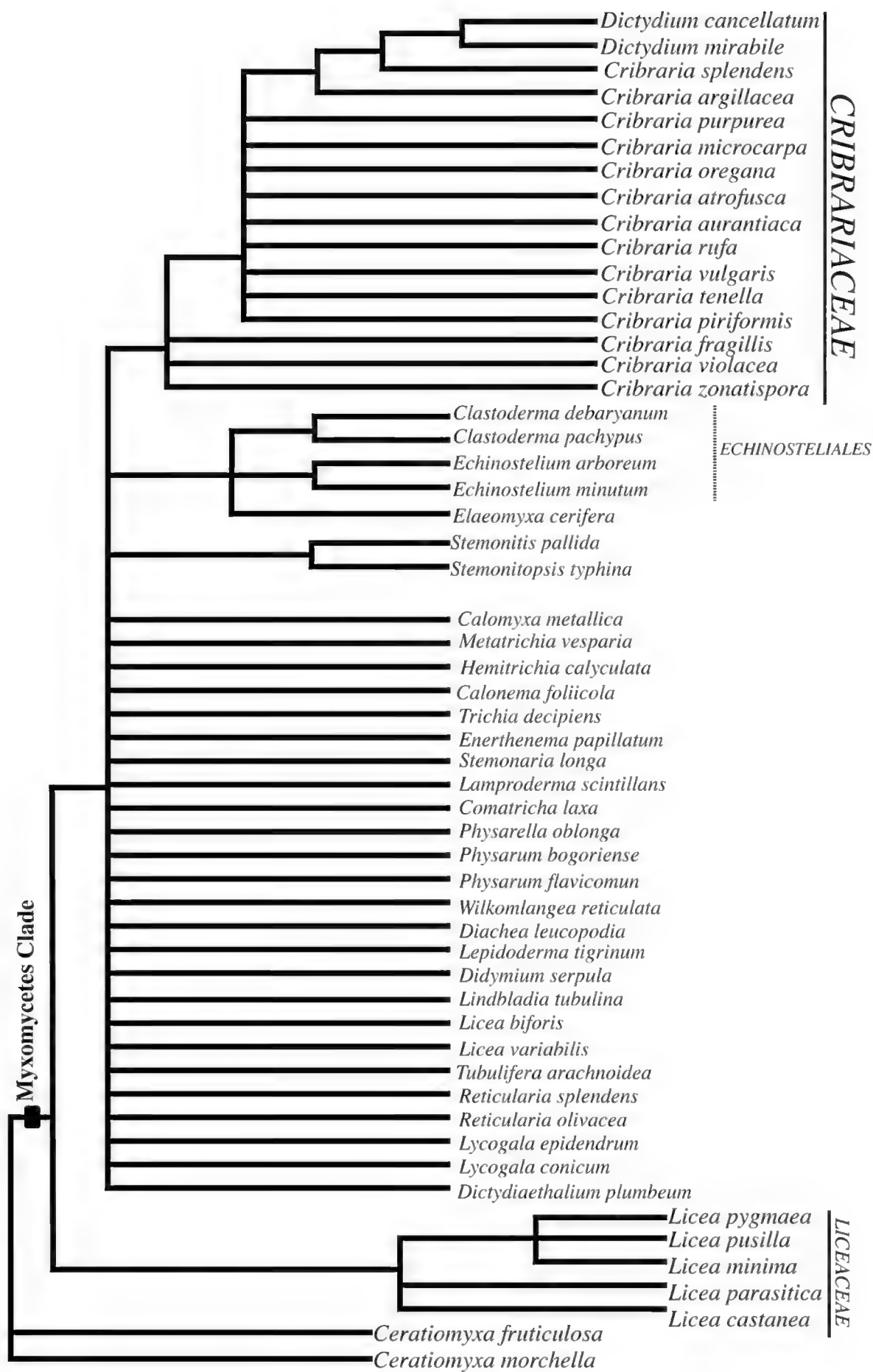


FIGURE 1. Strict unresolved consensus tree from an analysis using equal character weight.

for the deepest branches; nevertheless, four clades were recovered (FIG. 1): here referred as the *Cribrariaceae* (16 terminals without *Lindbladia*), the *Echinosteliales* (4 terminals) plus *Elaeomyxa cerifera*, the *Stemonitis* clade (2 terminals), and the *Liceaceae* clade (only 5 terminals).

The IW analysis generated seven trees with a best fit of -37.473 and a length of 167 steps, the same as the EW shortest trees. The strict consensus of IW trees (FIG. 2) is used below (see Discussion) to compare the relationships of *Cribrariaceae* and the remaining *Myxomycetes*.

The IW strict consensus revealed several taxonomically meaningful clades, including four main clades (FIG. 2). Clade 1 comprises the *Stemonitales*, *Echinosteliales*, and *Physarales* sensu Martin et al. (1983), a relationship found also by a previous molecular-based analysis (Fiore-Donno et al. 2008). Within clade 1, Sub-clade A shows the *Stemonitales* (S_A) and *Echinosteliales* (E_A) plus *Elaeomyxa cerifera* as sister groups. The phylogenetic position of *Diachea leucopodia* and *Lepidoderma tigrinum* is undefined within Subclade A. Sub-clade B comprises part of the *Physarales* sensu Martin et al. (1983). Jackknife analysis indicated a low-level support for Clade 1; only three clades (the *Stemonitis pallida* plus *Stemonitopsis typhina*, and the genera *Clastoderma* and *Echinostelium*) show Jackknife support above 80%. Most clades within Clade 1 were not supported by decay analysis either, and only the *Stemonitis pallida* plus *Stemonitopsis typhina* clade had a low Bremer support (= 2).

Clade 2 is sister to Clade 1 and encompasses three clades. The *Reticulariaceae* sensu Martin et al. (1983) plus *Lindbladia tubulina* and *Tubulifera arachnoidea* is a monophyletic group, which we call the *Reticulariaceae* (R). The Jackknife and Bremer support for this clade is low (60%, 2). The sister clade of this group is formed by *Calomyxa metallica* plus *Licea variabilis* and *Licea biforis* (part of *Liceaceae*, FIG. 2). A third clade composed of *Hemitrichia calyculata* and *Trichia decipiens* (part of *Trichiales*, FIG. 2) is sister to the *Reticulariaceae* and the *Calomyxa metallica* + *Licea variabilis* + *Licea biforis* clades.

In Clade 3, the strict consensus shows all 16 *Cribraria* species as a monophyletic group. We refer this as the *Cribrariaceae* clade (C). The Jackknife and Bremer support for this clade is 85% and 2 respectively. Sister to the *Cribrariaceae* clade is *Calonema foliicola* and (more basally) *Metatrichia vesparia* (both exemplars of the *Trichiales*).

Finally, Clade 4, here labeled as the *Liceaceae* clade (L), comprises five species of *Licea* sensu Martin et al. (1983). This is the basal group of the *Myxomycetes* clade (Jackknife value = 76%; Bremer support = 2).

Discussion

The IW results indicate monophyly for the *Stemonitales* and *Echinosteliales* but not for the *Physarales*, *Trichiales*, or *Liceales*, which appear either paraphyletic (*Physarales*) or polyphyletic (*Trichiales*, *Liceales*) (FIG. 2).

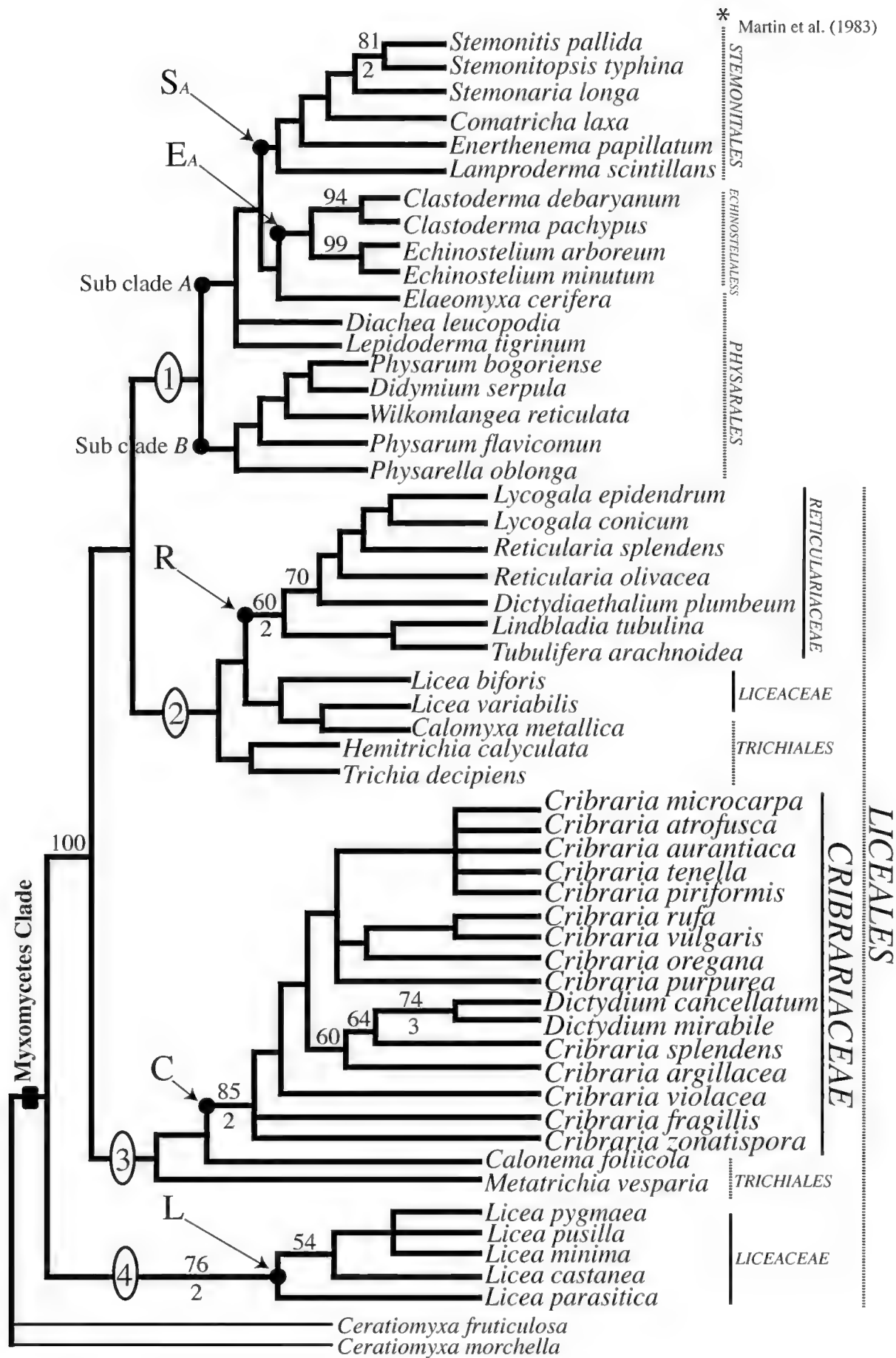


FIGURE 2. The strict consensus from seven trees using implied weights. Numbers in circles denote the principal clades considered here. Numbers above branches indicate Jackknife values; numbers below branches indicate the Bremer support.

***Liceales* are polyphyletic**

Our results suggest that the *Liceales* sensu Martin et al. (1983) are not monophyletic. The polyphyletic origin of the *Liceales* has been proposed before (Eliasson 1977). Currently, the order is delimited mostly by the lack of capillitium. However, Alexopoulos (1976), noting that absence of a capillitium was not a good taxonomical character, suggested that this character should be re-evaluated because other myxomycete species with small sporotheca occasionally lack a capillitium [e.g., some *Perichaena* species (*Trichiales*), Keller & Eliasson 1992; *Didymium eremophilum* (*Physarales*), Blackwell & Gilbertson 1980]. In contrast, small peridial inner projections have been found in some species of *Liceaceae* that may be perceived as the remains of a rudimentary capillitium (Alexopoulos 1976, Gilert 1985, Eliasson et al. 1991). Another example is *Listerella paradoxa*, a species currently included in *Liceales*, in which capillitium is present in the fructifications (Eliasson & Gilert 1982, Martin et al. 1983).

Eliasson (1977) and Eliasson et al. (1991) suggested that the assimilative stage, either a protoplasmodium or a phaneroplasmodium, might also indicate the heterogeneity of the *Liceales*. Unfortunately, because this information is unknown for the species we studied due to difficulties presented by axenic laboratory culture, it was not included in the analyses.

The results of the present study indicate that families currently classified in the order *Liceales* — *Reticulariaceae* (in Clade 2), *Liceaceae* (in Clades 2 and 4), *Cribrariaceae* (in Clade 3) — do not share a common ancestor (FIG. 2). Our analyses also shed some light on the taxonomic status of these three families.

In the character optimization, one unique synapomorphy— presence of a pseudoaethalium (character 4:1) — supports the monophyly of the *Reticulariaceae* (FIG. 3). All genera (*Lycogala*, *Reticularia*, *Dictydiaethalium*, *Tubulifera* = *Tubifera*) included in clade *R* have been traditionally recognized as part of *Reticulariaceae*, except for *Lindbladia*, a genus that has been classified in the *Cribrariaceae* (Martin & Alexopoulos 1969, Martin et al. 1983, Nannenga-Bremekamp 1991, Stephenson & Stempen 1994).

With respect to the monotypic *Liceaceae* sensu Martin et al. (1983), the genus *Licea* appears polyphyletic with some exemplar species shown in Clade 2 and others in Clade 4 (FIG. 2). *Licea variabilis* (in Clade 2) is non-typical compared to most *Licea* species in sporophore form (Martin & Alexopoulos 1969) and development of a phaneroplasmodium (McManus 1966). The *Liceaceae* in Clade 4 (*L. pygmaea*, *L. pusilla*, *L. minima*, *L. castanea*, *L. parasitica*) have the unique synapomorphy of a myxospore wall that is thinner at one pole (character 51:1), a character not present in *Licea biforis* and *L. variabilis*. These two taxa and *Calomyxa metallica* (in Clade 2) are supported by the presence of a sporocarp (character 3:1, FIG. 3).

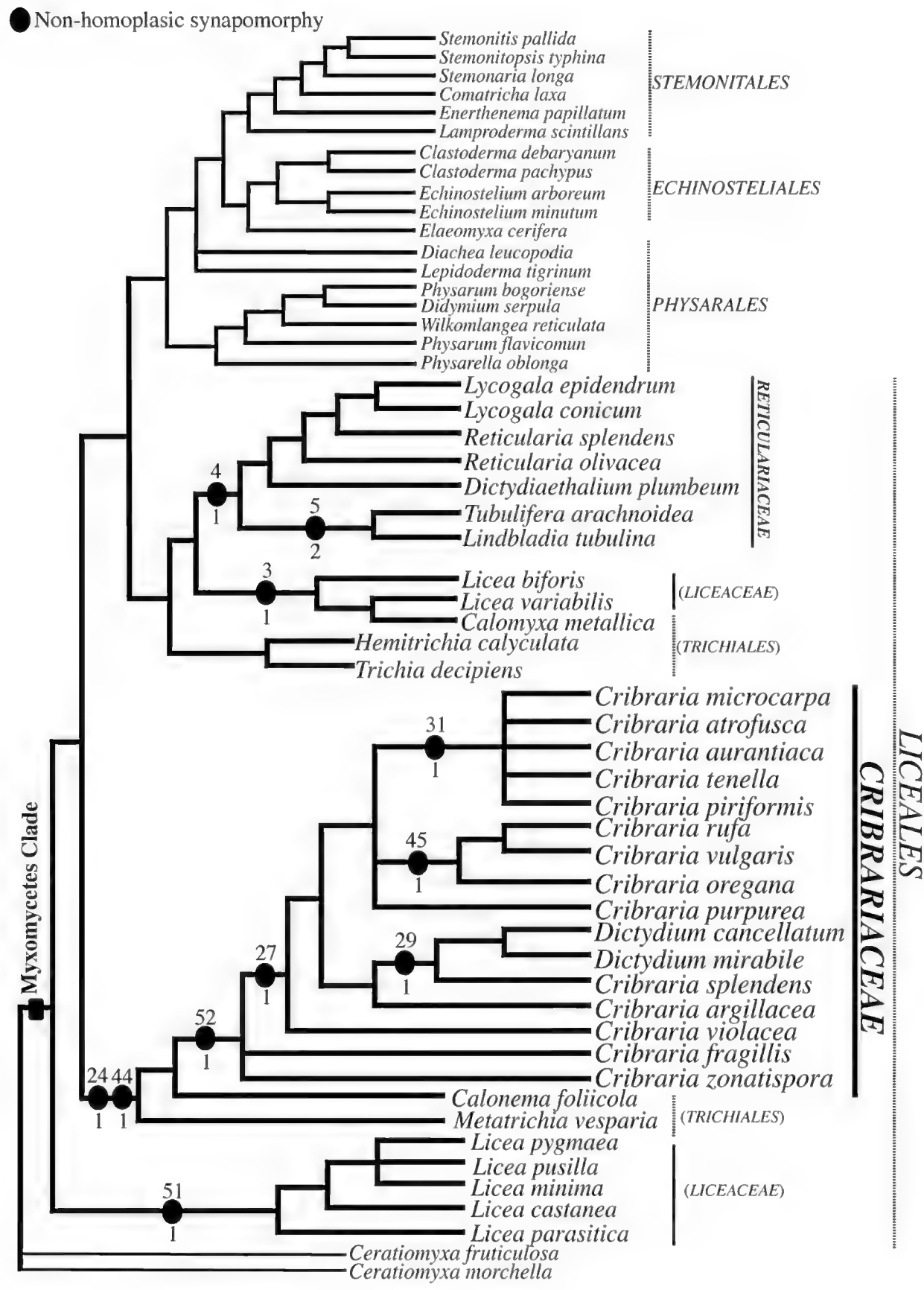


FIGURE 3. One of the most parsimonious trees encountered during implied weights search, showing the character states that can be unambiguously optimized. Numbers above dots indicate the character and number below dots indicate the character states.

Several workers (Alexopoulos 1973, Alexopoulos 1982, Fiore-Donno et al. 2005) have suggested a relationship between *Trichiales* and *Liceales* based on either the plasmodial common to both groups (Alexopoulos 1973, 1982) or molecular phylogenetic analysis (Fiore-Donno et al. 2005).

Phylogenetic position of *Cribrariaceae*

Our cladistic analyses support the monophyly of the *Cribrariaceae* (Clade C, FIG. 2). According to Martin (1949), Martin & Alexopoulos (1969), and Nannenga-Bremekamp (1991), plasmodic granules, the lack of a capillitium, and the persistent surface net in *Cribraria* species make them easy to recognize. The present analytical results show that the most robust delimitation of *Cribrariaceae* is supported by only one synapomorphy: the presence of the plasmodic granules (character 52:1, FIG. 3). Although *Cribraria* has been described with a peridial net, *C. fragilis* and *C. zonatispora* (both included in our analyses) lack this feature (Lado et al. 1999, Estrada-Torres et al. 2001). The two species resemble each other in producing spores with warts and smooth areas and sharing a xeric environment and succulenticolous habit (Estrada-Torres et al. 2001). These two distinctive species are unresolved at the base of the *Cribrariaceae* (FIG. 2). The clade of 14 species that excludes these two *Cribraria* species is supported by the presence of the peridial net (character 27:1, FIG. 3).

Our analyses were not intended to elucidate the relationships within the *Cribrariaceae*, although the tree topology did reveal other groups, including one diagnosed by pulvinate nodes (character 31:1, FIG. 3) formed by *C. microcarpa*, *C. atrofusca*, *C. aurantiaca*, *C. tenella*, and *C. piriformis*. Another group comprising *C. rufa*, *C. vulgaris*, and *C. oregana* is supported by the synapomorphy of warty-reticulate spore ornamentation (character 45:1, FIG. 3). Nevertheless relationships among these species are undefined, and Jackknife and Bremer values do not support these two clades (FIG. 2).

Our analytical results support *Dictydium* within *Cribraria* (FIG. 2). Martin & Alexopoulos (1969), Farr (1976), Martin et al. (1983), and Keller & Braun (1999) have considered *Dictydium* a separate genus within the *Cribrariaceae*, but as species with intermediate features between *Cribraria* and *Dictydium* make differentiation difficult (Nannenga-Bremekamp 1962), there is no reason to keep these genera separate.

According to Martin & Alexopoulos (1969), *Dictydium*, which comprises three species (*Dictydium cancellatum* = *Cribraria cancellata*, *D. mirabile* = *C. mirabilis*, *D. rutilum* = *C. rutila*), is characterized by a peridial net composed of almost parallel ribs connected by thin transverse filaments and lacking expanded nodes or thickenings. However, the upper third of the peridial net in *Dictydium mirabile* (= *Cribraria mirabilis*) nearly lacks subparallel ribs, as is

characteristic in *Cribraria*. On the other hand, species placed in *Cribraria* (e.g., *C. splendens*) exhibit a peridial net having almost parallel ribs in the lower part of the sporotheca. Our taxonomic sampling of *D. cancellatum* and *D. mirabile* show both in a clade sister to *C. splendens* (FIG. 2). The Jackknife support is relatively low (64%) and the presence of ribs as a peridial net remains the only synapomorphy for this clade (character 29:1, FIG. 3).

Another significant taxonomic analytical result shows *Lindbladia tubulina*, currently classified in the *Cribrariaceae* sensu Martin et al. (1983) based on presence of plasmodic granules, grouping not in the *Cribrariaceae* (Clade C, FIG. 2) but in the *Reticulariaceae* (Clade R, FIG. 2). In observing that plasmodic granules are usually conspicuous in *Cribrariaceae*, Martin & Alexopoulos (1969) noted that in *Lindbladia* they are few and concolorous with membranes. In contrast, Hatano et al. (1996) observed in a more detailed analysis, “Most *Lindbladia* specimens when viewed by light microscopy showed darkly pigmented and conspicuous dictydine granules on the peridium.” The *Lindbladia* specimens we studied have conspicuous plasmodic granules, corresponding more to Hatano et al. (1996) than Martin & Alexopoulos (1969).

Martin (1949) separated *Lindbladia* within the *Cribrariaceae* based primarily on the aethalioid and pseudoaethalioid habit and the lack of a peridial net. Hatano et al. (1996), however, mentioned the similarity of *Lindbladia* to *Dictydiaethalium*, *Enteridium*, and *Tubulifera* (= *Tubifera*) in the *Reticulariaceae* in its aethalioid and pseudoaethalioid habit. Our analytical results support the inclusion of *Lindbladia tubulina* in the *Reticulariaceae* by the sharing of a pseudoaethalium (FIG. 3). One reason for the contradictory literature descriptions (especially regarding the habit type) might be that gregarious forms of *Cribraria argillacea* have been confused with *Lindbladia* (Hatano et al. 1996). Our results place *Lindbladia tubulina* as sister of *Tubulifera arachnoidea* due to its spongy hypothallus (character 5:2, FIG. 3).

Our results show *Calonema foliicola* (*Trichiales*) as sister of the *Cribrariaceae*, although without Jackknife support (FIG. 2). This is relevant since relationships between *Cribrariaceae* and *Trichiales* have been inferred from cladistic analyses of molecular characters (elongation factor 1-alpha; see Fiore-Donno et al. 2005). They concluded that *Trichiales* (represented by *Trichia persimilis* and *Arcyria denudata*) was the sister group of *Cribrariaceae* (represented by *Cribraria cancellata*). Although Fiore-Donno et al. (2005) included only three taxa in their analyses, their results agree with relationships obtained here based on morphological analyses of 4 exemplars of *Trichiales* and 16 of *Cribrariaceae*.

Relationship between *Cribrariaceae* and *Trichiales* (as represented by *Calonema* and *Metatrachia*, Clade 3) is supported by the synapomorphy of the calyculus and the warted spore ornamentation (character 24:1; character 44:1, FIG. 3). Hatano (1985) divided the spore ornamentation into several subtypes.

He mentioned that both *Cribrariaceae* and *Trichiaceae* share the ornamentation with warts, as seen by SEM. In the case of the *Cribrariaceae* warts are generally connected to each other in a row and form ridges.

Spore color and phylogeny

Lister (1925) classified the *Myxogastria* (*Myxomycetes*) in two major groups according to the color of spore mass: *Lamprospora* with variously colored spores (seen in *Liceales* and *Trichiales* sensu Martin et al. 1983) but never violet-brown or purplish-gray and *Amaurospora* with violet-brown to purplish-gray spores (seen in *Physarales* and *Stemonitales* sensu Martin et al. 1983) or colorless spores (seen in *Echinostelium*). In this context, any phylogenetic study has been driven to define these relationships. Nevertheless, the Fiore-Donno et al. (2005) molecular analyses support Lister's classification scheme, including *Stemonitales* and *Physarales* within a "dark-spored" clade, *Liceales* and *Trichiales* within a "clear-spored" clade, and *Echinosteliales* as sister of the "dark-" + "clear-spored" clade.

We coded several states for the whole range of spore color visible under light microscopy (i.e., colorless, yellow, brown-yellow, dark-brown, purple, red; see APPENDIX 2). Here the clades found by Fiore-Donno et al. (2005) differed from those we recovered from the EW and IW multi-state spore color analyses (FIGS. 1 and 2). Although the colorless-spored *Liceales* and *Trichiales* are related within Clade 2 and 3 in our results, these two orders do not form a monophyletic group. Our IW analysis includes all dark-spored taxa (*Physarales* and *Stemonitales* sensu Martin et al.) and the colorless-spored *Echinosteliales* (Lister 1925) within Clade 1 (FIG. 4).

In Fiore-Donno et al. (2005), the dark-spored representatives are not sister groups. Instead, the colorless-spored *Echinosteliales* are sister to the dark-spored *Stemonitales*, suggesting that dark spores appear in two separate clades with colorless spores appearing in several independent branches (FIG. 4).

Our results may appear to be biased in view of the different coding of spore color character as interpreted by Lister (1925, dark vs. clear spores). An additional analysis was performed to test the effect of including the spore color in three states as Lister (1925) proposed in his classification scheme. This character coding was as follows: dark spores (*Physarales* and *Stemonitales* sensu Martin et al.), clear spores (*Trichiales* and *Liceales* sensu Martin et al.), and hyaline spores (*Echinosteliales* sensu Martin et al.). The strict consensus tree shows a different topology with respect to the multi-state spore color code.

Results show the dark-spored representatives (Fiore-Donno et al. 2005) as a monophyletic group but including the colorless-spored *Echinosteliales*. Clear-spored orders (Fiore-Donno et al. 2005) are not a monophyletic group. Part of the *Liceales* (*Cribrariaceae*) and *Trichiales* is sister to the dark-spored clade, but

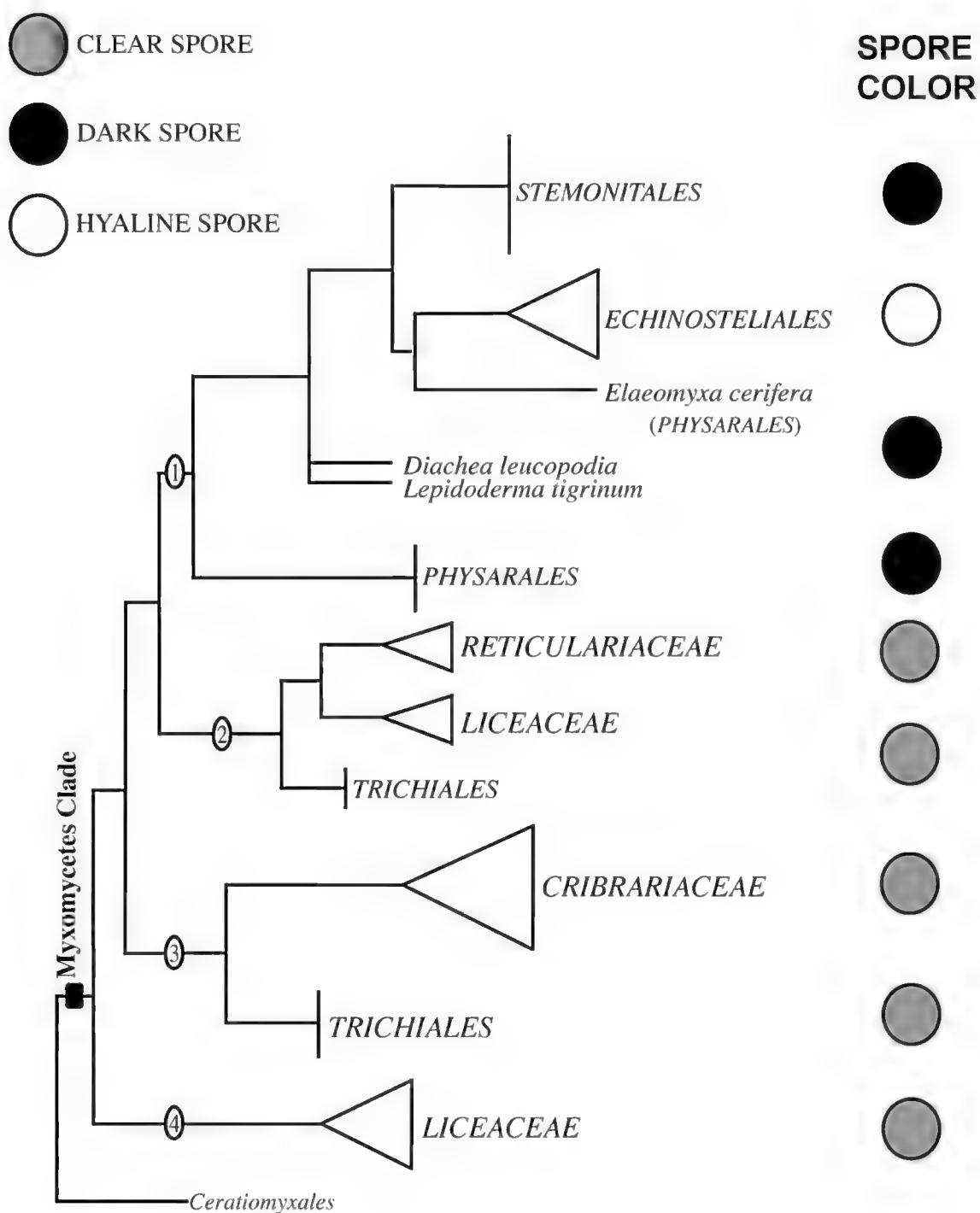


FIGURE 4. One of the MPTs based on implied weighting with the spore color (dark spores vs. clear spores) optimization as proposed by Fiore-Donno et al. (2005). This cladogram suggests that dark spores cluster in two separate clades, whereas clear-spores appeared in several branches independently.

another clade with the *Reticulariaceae* and part of the *Liceaceae* is sister to the dark-spored + *Cribrariaceae* and *Trichiales* clades.

Different spore color character coding (three state vs. multi-state) produces different hypotheses of internal relationships among the myxomycete orders. Fiore-Donno et al. (2005) observed that spore color might be a consistent morphological marker for slime mold phylogeny, but our incongruent trees

contradict their assumptions. We choose the multi-state code in order to include the whole variation visible under microscope.

Multi-state coding of spore color, together with the other morphological characters analyzed, were important in defining the dark-spored clade groups (*Stemonitales* and *Physarales*), therefore the multi-state coding is better than the two state code to resolve the phylogenetic history of *Myxomycetes*.

Kalyanasundaram et al. (1994), who studied the spore wall pigments of several *Myxomycetes*, found that melanin is the only pigment present in the dark-spored orders *Physarales* and *Stemonitales*. They also found melanin in the clear-spored *Liceales* and *Trichiales* and explained the clear spore color by suggesting that other pigments were present that masked the melanin. Further evaluation of additional spore color pigments is needed.

In conclusion, our phylogenetic analytical results derived from morphological characters indicate that the *Liceales* is not a monophyletic group, as several authors have proposed (Alexopoulos 1976, Eliasson 1977, Eliasson et al. 1991). The analyses also suggest that *Dictydium* should be considered part of *Cribraria* (as proposed by Nannenga-Bremekamp, 1962) and not a separate genus, given that a peridial net, the presence of ribs, and plasmodic granules are shared in both genera. *Cribraria* should be amended to include species lacking a peridial net in the sporophores, such as *C. zonatispora* (Lado et al. 1999) and *C. fragilis* (Estrada-Torres et al. 2001). Although *Lindbladia tubulina* is now included in the *Reticulariaceae*, analysis of more characters or the inclusion of *Cribraria cribrarioides* (= *Lindbladia cribrarioides*) might help to clarify their phylogenetic position, either in the *Cribrariaceae* or the *Reticulariaceae*, as our results suggest. Our study also reveals the phylogenetic value of morphological characters. Clark (2000) suggested that myxomycete morphological analysis is problematic due to character plasticity and the difficulty in growing fruitbodies in the laboratory. Nevertheless, careful examination of morphological variation, unbiased character assessment, and adequate character state coding methodology will help reveal patterns of phylogenetic congruence among characters, which could be useful to define the *Cribrariaceae* in a cladistic framework.

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Literature cited

- Alexopoulos CJ. 1973. The evolution of the taxonomy of the *Myxomycetes*. pp. 1–8, in CV Subramanian (ed.), *Taxonomy of Fungi* part I. Madras, University of Madras.
- Alexopoulos CJ. 1976. Absence of capillitium as a taxonomic character in the *Myxomycetes*. *Trans. Br. Mycol. Soc.* 66: 329.
- Alexopoulos CJ. 1982. Morphology, taxonomy and phylogeny. 3–23, in HC Aldrich, HW Daniel (eds.), *Cell biology of Physarum and Didymium*. Vol. 1. New York, Academic Press.
- Blackwell M, Gilbertson RL. 1980. *Didymium eremophilum*: a new myxomycete from the Sonoran desert. *Mycologia* 72: 791–797.
- Bremer K. 1994. Branch support and tree stability. *Cladistics* 10: 295–304.
- Clark J. 2000. The species problem in the *Myxomycetes*. *Stapfia* 73: 39–53.
- De Luna E, Mishler B. 1996. El concepto de homología filogenética y la selección de caracteres taxonómicos. *Bol. Soc. Bot. Méx.* 59: 131–146.
- De Pinna MC. 1991. Concepts and tests of homology in the cladistic paradigm. *Cladistics* 7: 367–394.
- Eliasson UH. 1977. Recent advances in the taxonomy of *Myxomycetes*. *Bot. Not.* 130: 483–492.
- Eliasson UH, Gilert E. 1982. A SEM-study of *Listerella paradoxa* (*Myxomycetes*). *Nordic Journal of Botany* 2(3): 249–255.
- Eliasson UH, Keller HW, Schoknecht JD. 1991. *Kelleromyxa*, a new generic name for *Licea fimicola* (*Myxomycetes*). *Mycol. Res.* 95: 1201–1207.
- Eriksson T. 1999. AutoDecay. Version 4.0. Bergius Foundation, Royal Academy of Sciences.
- Estrada-Torres A, Lado C, Rodríguez-Palma M. 2001. Two new species of *Myxomycetes* from a tropical deciduous forest from México. *Mycologia* 93: 744–750.
- Farr ML. 1976. *Myxomycetes*. *Flora Neotropica* 16. New York, New York Botanical Garden.
- Farr ML. 1981. How to know the true slime molds. Iowa, Wm. C. Brown Company.
- Farris JS. 1983. The logical basis of phylogenetic analysis. pp. 7–36 in NI Platnick, VA Funk (eds.), *Advances in cladistics*, Volume 2. New York, Columbia University Press.
- Farris JS, Albert VA, Källersjö M, Lipscomb D, Kluge AG. 1996. Parsimony jackknifing outperforms neighbour-joining. *Cladistics* 12: 99–124.
- Fiore-Donno AM, Berney C, Pawlowski J, Baldauf SL. 2005. Higher-order phylogeny of plasmodial slime molds (*Myxogastria*) based on elongation factor 1-A and small subunit rRNA gene sequences. *J. Eukaryot. Microbiol.* 52: 1–10.
- Fiore-Donno AM, Meyer M, Baldauf SL, Pawlowski J. 2008. Evolution of dark-spored *Myxomycetes* (slime molds): Molecules versus morphology. *Mol. Phylogenet. Evol.* 46: 878–889.
- Gilert E. 1985. Ultrastructure of *Licea kleistobolus* (*Myxomycetes*) and its bearing on the taxonomic affinity of the species. *Nord. J. Bot.* 5: 569–575.
- Goloboff PA. 1993. Estimating character weights during tree search. *Cladistics* 9: 83–91.
- Goloboff PA. 1997. Self-weighted optimization: tree searches and character states reconstructions under implied transformation costs. *Cladistics* 13: 225–245.
- Gray WD, Alexopoulos CJ. 1968. *Biology of the Myxomycetes*. New York, Ronald Press.
- Hatano T. 1985. Studies on the *Myxomycetes* of Japan, with particular reference to the fine structures of spores and capillitia. *Rep. Environm. Sci. Mie Univ.* 10: 25–106.
- Hatano T, Arnott J, Keller HW. 1996. The genus *Lindbladia*. *Mycologia* 88: 316–327.
- Hawksworth DL, Kirk BC, Sutton BC, Pegler DN. 1995. *Dictionary of the Fungi*. Ed. 8. Wallingford, CAB International.
- Hernández-Crespo JC, Lado C. 2005. An on-line nomenclatural information system of *Eumycetozoa*. <http://www.nomen.eumycetozoa.com>
- Kalyanasundaram I, Menon L, Loganathan P. 1994. Occurrence of melanin in bright-spored *Myxomycetes*. *Cryptog. Mycol.* 15: 229–237.

- Keller HW, Eliasson UH. 1992. Taxonomic evaluation of *Perichaena depressa* and *P. quadrata* based on controlled cultivation, with additional observations on the genus. *Mycol. Res.* 96: 1085–1097.
- Keller HW, Braun KL. 1999. *Myxomycetes* of Ohio: Their Systematics, Biology, and use in teaching. Ohio City, Biological Survey.
- Lado C, Pando F. 1997. *Myxomycetes*, I. *Ceratiomyxales*, *Echinosteliales*, *Liceales*, *Trichiales*. *Flora Mycologica Iberica* 2. Real Jardín Botánico de Madrid, Cramer.
- Lado C, Mosquera J, Beltrán-Tejera E. 1999. *Cribraria zonatispora*, development of a new myxomycete with unique spores. *Mycologia* 91: 157–165.
- Lopardo L. 2005. Phylogenetic revision of the spider genus *Negayan* (Araneae, Anyphaenidae, Amaurobioidinae). *Zoologica Scripta* 34: 245–277.
- Lister A. 1894. A monograph of the *Mycetozoa*. London, British Museum Natural History.
- Lister A. 1911. A monograph of the *Mycetozoa*. Ed. 2, (revised by G. Lister). London, British Museum Natural History.
- Lister A. 1925. A monograph of the *Mycetozoa*. Ed. 3, (revised by G. Lister). London, British Museum Natural History.
- Macbride TH, Martin GW. 1934. *The Myxomycetes*. New York, Macmillan Company.
- McManus MA. 1966. Cultivation on agar and study of the plasmodia of *Licea biforis*, *Licea variabilis* and *Cribraria violacea*. *Mycologia* 58: 479–483.
- Maddison WP, Maddison DR. 2002. MacClade version 4.05: Analysis of Phylogeny and Character Evolution. Sinauer Associates. Sunderland, Massachusetts.
- Martin GW. 1949. *Fungi. Myxomycetes*. N. Am. Fl. 1: 1–151.
- Martin GW. 1960. The systematic position of the *Myxomycetes*. *Mycologia* 52: 119–129.
- Martin GW, Alexopoulos CJ. 1969. *The Myxomycetes*. Iowa City, University of Iowa Press.
- Martin GW, Alexopoulos CJ, Farr ML. 1983. *The genera of Myxomycetes*. Iowa City, University of Iowa Press.
- Massee G. 1892. A monograph of the *Myxomycetes*. London, Methuen & Co.
- Nannenga-Bremekamp NE. 1962. Notes on *Myxomycetes* V: On the identity of the genera *Cribraria* and *Dictydium*. *Acta Bot. Neerl.* 11: 21–22.
- Nannenga-Bremekamp NE. 1991. A guide to temperate *Myxomycetes*. Bristol, Biopress.
- Nixon KC. 1999. The parsimony ratchet, a new method for rapid parsimony analysis. *Cladistics* 15: 407–414.
- Olive LS. 1975. The *Mycetozoa*: A revised classification. *Bot. Rev.* 36: 59–89.
- Schoknecht JD. 1975. SEM and X-ray microanalysis of calcareous deposits in *Myxomycetes* fructifications. *Trans. Amer. Microscop. Soc.* 94: 216–223.
- Sikes DS, Lewis PO. 2001. Beta software, version 1. PAUPRat: PAUP* implementation of the parsimony ratchet. Storrs, Department of Ecology and Evolutionary Biology, University of Connecticut, distributed by the authors.
- Spiegel FW. 1990. Phylum plasmodial slime molds, class *Protostelida*. pp. 484–497, in L Margulis et al. (eds.), *Handbook of Protoctista*. Boston, Jones and Bartlett.
- Spiegel FW, Lee SB, Rusk SA. 1995. Eumycetozoans and molecular systematics. *Can. J. Bot.* 73: 738–746.
- Stephenson S, Stempen H. 1994. *Myxomycetes*. A handbook of slime molds. Portland, Timber Press.
- Swofford DL. 2002. PAUP*. Phylogenetic Analysis Using Parsimony (*and other methods). Version 4.0b4. Sinauer Associates. Sunderland, Massachusetts.
- Wenzel JW. 2002. Phylogenetic analysis: the basic method. pp. 4–30, in R De Salle et al. (eds.), *Techniques in molecular systematics and evolution*. New York, Birkhäuser.

Appendix 2. Characters and character states

(Morphology of the sporophore)

- 1.- AETHALIUM: A relatively large, sessile, round or mound-shaped fruiting body formed from all or a major portion of plasmodium. Common in some members of *Liceales* and *Physarales*. 0 = absence; 1 = presence.
- 2.- PLASMODIOCARP: A sessile, branched, ring-shaped, or netted type of fruiting body formed when a plasmodium becomes concentrated in its main veins during fruiting. 0 = absence; 1 = presence.
- 3.- SPOROCARP: A type of fruiting body formed when a plasmodium breaks up into a small portions, each of which develops into a single stalked or sessile unit. It is the most common fruiting body in taxa of all orders in *Myxomycetes*. 0 = absence; 1 = presence.
- 4.- PSEUDOAEETHALIUM: A type of fruiting body that consist of a mass of sporangia tightly packed together to resemble an aethalium. It is present in *Dictydiaethalium plumbeum*, *Tubulifera arachnoidea* (both members of *Reticulariaceae*); *Lindbladia tubulina* (*Cribrariaceae*), and *Metatrichia vesparia* (*Trichiaceae*). 0 = absence; 1 = presence.
- 5.- TYPE OF HYPOTHALLUS: The hypothallus is a layer deposited by the plasmodium at the time of fruiting, located at the base of sporangia in the substrate. Normally, in mostly of *Myxomycetes*, the hypothallus may appear as a delicate or tough membrane, but it may appear conspicuous and spongy or limy, like occur in *Lindbladia tubulina*, *Tubifera miscrosperma* or *Mucilago crustacea*. It could be also mucilaginous, massive and solid as in *Ceratiomyxales*. 0 = massive solid; 1 = membranous; 2 = spongy.
- 6.- STALK: The stalk is a structure which support the sporotheca (the structure where the spores develop), raising up from the substrate. It may display a diverse range of length, thickness, colors and textures (Farr 1981). 0 = absence; 1 = presence.
- 7.- NATURE CONTENT OF STALK: The stalk may be hollow, as it happens in most of the *Stemonitales*, or filled with several kinds of materials as occur in *Liceales* or *Trichiales*. 0 = solid; 1 = hollow.
- 8.- CYSTS IN THE STALK: The stalk of some species of *Trichiales* are filled with vesicular structures resembling spores, but larger, which are called cysts. In our data set, the species that have cysts as filling material are *Hemitrichia calyculata*, *Calonema foliicola*, and *Trichia decipiens*. 0 = absence; 1 = presence.
- 9.- LIME IN THE STALK: Another filling material frequently present in the stalk is calcium carbonate granules. It is present in some species of *Physarales*, such as *Diachea leucopodia*, and *Lepidoderma tigrinum*. 0 = absence; 1 = presence.
- 10.- FIBERS IN THE STALK: According with Gray and Alexopoulos (1968), the stalk in the species of *Comatricha* and *Clastoderma* consists of a system of parallel fibers. In our matrix, this character is present in *Enerthenema papillatum*, *Lamproderma scintillans*, and *Comatricha laxa*. 0 = absence; 1 = presence.
- 11.- CAPILLITIUM: A system of sterile threads or tubules found within the spore mass of the fruiting body of many *Myxomycetes*. It may aid to the dissemination of spores. With the exception of the *Liceales*, it is present in most of the other species of *Myxomycetes*. The capillitium is a very important and useful character in the identification of orders, families, genera and species (Farr 1981). 0 = absence; 1 = presence.
- 12.- TYPE OF CAPILLITIUM: The capillitium may be formed by threads, i.e. solid structures, as in *Calomyxa metallica*, or tubules i.e. hollow structures, as in the most of *Physarales*, *Trichiales* and *Stemonitales*. 0 = hollow; 1 = solid.
- 13.- CAPILLITIUM ORNAMENTATION: It is applicable for those capillitial threads or tubules not smooth, which have the surface marked or sculptured with spines, warts, dots, rings, reticules, etc. It is an essential character in the generic and specific distinction of *Trichiales*. 0 = absence; 1 = presence.

- 14.- CAPILLITIUM COLOR: This refers to the color of the capillitial threads or tubules observed under the light microscope. Generally in the *Stemonitales* the capillitium is dark and slender, while in the *Trichiales* it is mostly pale or brightly colored. Some species of *Physarales* have a pale capillitium. We coded according with the range-color we observed in the taxa we studied. 0 = pale; 1 = reddish; 2 = yellow; 3 = dark brown.
- 15.- ATTACHMENT OF THE CAPILLITIUM: The capillitium threads or tubules may be free or attached either to the columella or the peridium. 0 = free; 1 = attached.
- 16.- CAPILLITIUM ATTACHMENT TO THE COLUMELLA: It is mostly present in the *Stemonitales* and *Echinosteliales*, but some members of *Physarales* (*Diachea leucopodia* and *Elaeomyxa cerifera*) have it too. 0 = absence; 1 = presence.
- 17.- CAPILLITIUM ATTACHMENT TO THE PERIDIUM: In some species of *Myxomycetes*, the tips of the elements of the capillitium stay attached to the peridium, leaving fragments of it in the surface of the sporotheca. In some *Trichiales* the capillitium is adhered to the calyculus, the persistent like-cup peridium in the base of their sporothecae. 0 = absence; 1 = presence.
- 18.- PLACE OF ATTACHMENT BETWEEN CAPILLITIUM AND COLUMELLA: The capillitium may arise along all the columella or only at the apex of this structure. 0 = to the apex; 1 = along the columella.
- 19.- BRANCHING OF THE CAPILLITIUM: The elements of the capillitium may be simple, branched or branched-anastomosed forming a complex reticulated structure. 0 = simple; 1 = branched; 2 = anastomosed.
- 20.- CAPILLITIUM SUPERFICIAL NET: Some species of *Myxomycetes* have a superficial net formed by the anastomosis of the capillitial elements in the surface of the sporotheca, as present in species of the genus *Stemonitis*. 0 = absence; 1 = presence.
- 21.- CALCIUM CARBONATE IN THE CAPILLITIUM: In the *Physarales*, the capillitium may be entirely limy, such as in a typical *Badhamia*, or may consist of a system of hyaline tubules supporting calcareous nodes like in *Physarum*. In other families lime is rarely present in the capillitium even though lime may be characteristically deposited in other parts of the fructification. 0 = absence; 1 = presence.
- 22.- BIREFRINGENCE OF CAPILLITIUM: Birefringence is found only in the capillitium of some *Trichiales*. Most of the species that have spirals on the capillitium show very brilliant birefringence (Nannenga-Bremekamp 1982). We used this character in order to define the relationships within the *Trichiales* order. 0 = absence; 1 = presence.
- 23.- PERIDIUM: The peridium (plural: peridia) is a covering that encloses the spore mass (plus other structures) of a fruiting body. The peridium may be tough, thin or delicate, persisting in the mature reproductive body or disappearing, partially or totally, after the spores become mature. 0 = persistent; 1 = partially persistent; 2 = fugacious.
- 24.- CALYCVULUS: The calyculus is the persistent basal portion of the peridium, forming a cup-shaped structure at the bottom of the sporothecae in some species of *Hemitrichia*, *Arcyria* or *Trichia* in the order *Trichiales*, and *Cribraria* or *Lindbladia* in the order *Liceales*. 0 = absence; 1 = presence.
- 25.- DEPTH OF THE CALYCVULUS: The calyculus may be shallow, ranging 1/3 or less than the height of the sporotheca, or deep, occupying more than 1/3. 0 = shallow; 1 = deep.
- 26.- MARGIN OF THE CALYCVULUS: The calyculus may have smooth margin or have projections forming an irregular margin with teeth or ribs. 0 = irregular; 1 = regular.
- 27.- PERIDIAL NET: This is a persistent peridium which remains as a reticulate structure in the sporotheca of some members of the *Cribrariaceae* (Martin and Alexopoulos 1969). 0 = absence, 1 = presence.
- 28.- THREADS FREE IN THE PERIDIAL NET: The free ending threads in the peridial nets of certain species of *Cribraria*. 0 = absence; 1 = presence.

- 29.- RIBS IN THE PERIDIAL NET: Sub parallel elements of the peridial net, always inter connected by short transverse threads. They may arise from the base of the sporotheca or from the calyculus. 0 = absence; 1 = presence.
- 30.- NODES IN THE PERIDIAL NET: An expanded junction of the threads in the peridial net of the reproductive body of some members of *Cribrariaceae*. 0 = absence; 1 = presence.
- 31.- TYPE OF NODES: The nodes can be flattened or thickened by the aggregation of the plasmodic granules. Thickened nodes are pulvinate in lateral view. 0 = not pulvinate; 1 = pulvinate.
- 32.- PERIDIAL COLLAR: The remains of the peridium around the stalk at the base of the sporotheca is called a peridial collar. 0 = absence; 1 = presence.
- 33.- PERIDIAL PLATES: The peridium of some species of *Licea* is composed by polygonal plates which give a polyhedral shape to the sporotheca. 0 = absence; 1 = presence.
- 34.- LIME IN THE PERIDIUM: CaCO_3 may be present in the peridium of many species of *Physarales*, either as crystals or granules. 0 = absence; 1 = granules; 2 = crystals.
- 35.- COLUMELLA: A sterile structure that extends into the spore mass from below, as an extension of the stalk. It occurs in certain genera belonging to the orders *Echinosteliales*, *Physarales*, and *Stemonitales*. 0 = absence; 1 = presence.
- 36.- TYPE OF COLUMELLA: The columella may be spherical, hemispherical club-shaped, elongated, dome-shaped or reduced as a thickened sporangial base. In our study, only elongate and hemispherical states were present in the taxa included. 0 = elongate; 1 = hemispherical.
- 37.- LIME IN COLUMELLA: As occurs with other structures, CaCO_3 may be present in the form of granules in the columella. 0 = absence; 1 = presence.
- 38.- COLUMELLA EXTENDING: The length of the columella can reach the apex, the middle portion, or only at the base of the sporotheca. 0 = to the apex of sporotheca; 1 = to the middle of sporotheca; 2 = to the base of sporotheca.
- 39.- PROOSPORES: An uninucleate segment of the protoplasm. It is found on the surface of the columns of the reproductive fructification of the *Ceratiomyxales*, and gives rise to one sporocarp. 0 = absence; 1 = presence.
- 40.- TYPE OF MYXOSPORES: It refers to the shape of the spores. It is an important character in *Myxomycetes* taxonomy. In this work we don't include all existing forms, but only the states for the taxa we analyzed. 0 = globose; 1 = elliptical; 2 = angular; 3 = sub-globose; 4 = discoid.
- 41.- COLOR OF MYXOSPORES: A further important feature is spore color, which appears darker in the mass in reflected light under the hand lens or dissecting microscope than with transmitted light as seen under the microscope. We coded this character with observations under the light microscope in order to define more precisely the range of color states present in all *Myxomycetes*. 0 = hyalines; 1 = reddish; 2 = yellowish; 3 = brown-dark; 4 = purple; 5 = brown-yellowish.
- 42.- NUMBER OF SPORES FORMED IN THE SPOROTHECA: The sporotheca of some protostelids form a unique spore in their fruit body, such as *Ceratiomyxa* (outgroup). The *Myxomycetes* generally produce many spores by sporotheca. 0 = monosporic; 1 = multisporic.
- 43.- ORNAMENTATION OF THE MYXOSPORES: The surface of the spore, as seen under light microscope, might be smooth or with projections of diverse forms. 0 = absence; 1 = presence.
- 44.- ORNAMENTATION WITH WARTS: The warts are short projections, dispersed in surface of the spore and obtuse in the apex. 0 = absence; 1 = presence.
- 45.- ORNAMENTATION WARTED-RETICULATED: The warts might be lined, with the lines forming a reticulum. It is present in this study only for three species of the *Cribrariaceae* (*C. rufa*, *C. oregana* and, *C. vulgaris*). 0 = absence; 1 = presence.
- 46.- ORNAMENTATION WITH BANDED-RETICULATED: This ornamentation is formed by bands that form a reticulate. Representatives of the *Liceales* and *Trichiales* share this type of ornamentation. 0 = absence; 1 = presence.
- 47.- ORNAMENTATION WITH RUGULOSE: It is formed by folds in the surface of the spore. 0 = absence; 1 = presence.

- 48.- ORNAMENTATION WITH SPINES: This ornamentation is formed by conical with sharp apex. 0 = absence; 1 = presence.
- 49.- ORNAMENTATION WITH DOTS: Very tiny projections giving a dotted appearance on the surface of the spore. 0 = absence; 1 = presence.
- 50.- ORNAMENTATION WITH CRESTAE: This ornamentation is formed by projections giving a wavy aspect. 0 = absence; 1 = presence.
- 51.- MYXOSPORE WALL: The myxospore wall might be homogenous in thickness or have a thinner and paler area at one pole, as seen in light microscopy. 0 = homogenous; 1= with a diffuse thinner wall at one pole.
- 52.- PLASMODIC GRANULES: Microscopic, usually dark-colored structures found in the fruiting bodies of *Cribrariaceae*. They are called also “dictydine granules” (Martin and Alexopoulos 1969) or “lime globules” (Nannenga-Bremekamp 1991). 0 = absence; 1 = presence.
- 53.- PSEUDOCAPILLITIUM: A system of irregular plates, tubes, or threadlike elements occurring within the spore mass, and suggestive of a true capillitium but not formed in the same way; it is characteristic of some members of the *Liceales*. 0 = absence; 1 = presence.
- 54.- THREAD PHASE: It is a tetra nucleate and elongate thread phase produced immediately after the germination of the spores of the *Ceratiomyxales*. 0 = absence; 1 = presence.

***Lomachashaka gomaya*, a new sporodochial hyphomycete from India**

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Abstract — *Lomachashaka gomaya*, a new sporodochial hyphomycete isolated from cattle dung collected from the forests of Western Ghats, Karnataka State, India, is described and illustrated. It is accommodated in the genus because of its hyaline setae with bulbous base and conidia with cupulate, mucoid apical appendages. It differs from other species in the genus by its longer setae, verrucose conidiophores and smaller conidia with the dimensions $6.5\text{--}8.5 \times 2.5\text{--}3.5\mu\text{m}$.

Key words — anamorphic fungus, biodiversity

Introduction

During a survey of microfungi of the forests of Western Ghats in southern India, a novel sporodochial fungus was isolated from cattle dung collected at Yana, a tiny hamlet amidst dense and pristine tropical forests, 30 km from Kumta, Uttara Kannada District, Karnataka State, India (latitude $14^{\circ} 26' \text{ N}$, longitude $74^{\circ} 27' \text{ E}$).

Materials and methods

Partially decomposed, air-dried cattle dung was taken to the laboratory in paper bags. A small lump of the dung was rehydrated using sterile distilled water and incubated in a sterile moist chamber. After 8 days of incubation, fungal fruit bodies appeared on the dung. The fungus was studied under stereo- and binocular microscopes. A pure culture was established by streaking a sterile needle tip-full of conidia on 2% malt extract agar (HiMedia, India) containing antibiotics (bacitracin 0.02 g, neomycin 0.02 g, penicillin 0.02 g, streptomycin 0.02 g and tetracycline 0.04 g dissolved in 10 ml of sterile distilled water, added to 1 L medium). Germinated individual conidia were transferred onto malt extract agar slants for culture maintenance.

Taxonomic description

Lomachashaka gomaya S.K.Yadav & Bhat, sp. nov.

FIGURES 1–7

MYCOBANK MB 513542

Coloniae lente crescentes in agaro extracto malti, albae, mycelium floccosum, hyalinum lanatum, 4mm diam. post 20 dies 22–24°C. Sporodochia superficialia, dispersa vel 2–3 aggregata, viridia vel viridulo-atra, 200–235 µm alta, 150–160 µm diametro Setae numerosae hyalinae, laeves, crassitunicatae, verrucosae ad basim, sursum obtusae vel rotundatae, septatae, cellulis lumine reducto, non ramosae, 110–190 µm longae, 6–6.3 µm latae Conidiophora aggregata, integrata, subhyalina, verrucosa, septata, ramosa, 75–95 × 2.0–8.5 µm. Cellulae conidiogenae monophialidicae, verrucosae, subhyalinae, 8–14.5 × 2 µm, collare conspicuum formantes. Conidia fusiformi-ellipsoidea, sursum acuta, unicellularia, subhyalina, laevia, 6.5–8.5 × 2.5–3.5 µm, appendice funiculari, cupulari, mucido, hyaline, 2–3 µm lato praedita.

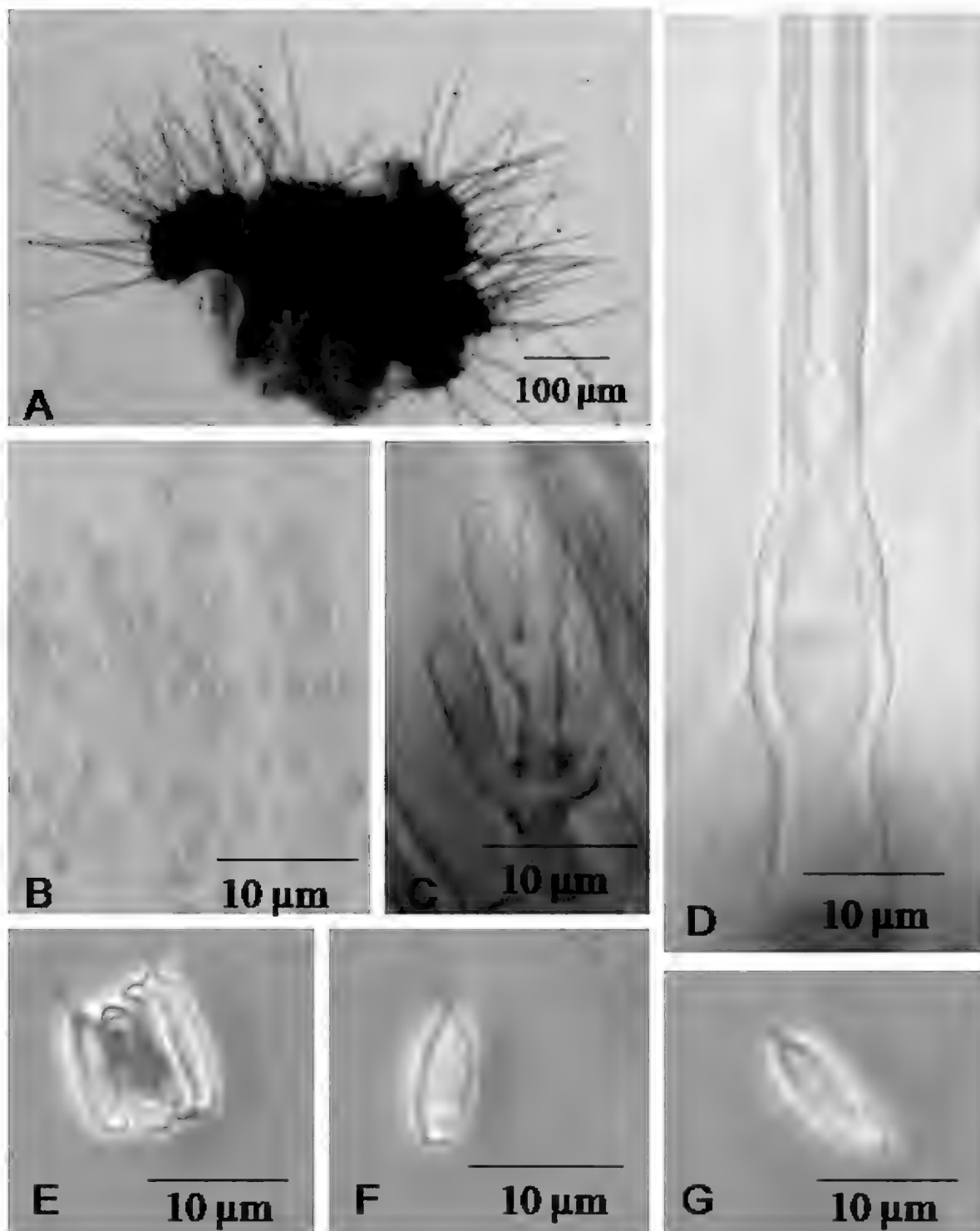
HOLOTYPE: On cow dung, Yana, Uttara Kannada District, Karnataka State, India. 27.07.2008 col. Ashish Prabhugaonkar Herb. No. HClO 49196

ETYMOLOGY: *gomaya* (Sanskrit), referring to the substrate, cattle dung.

Colonies slow growing, attaining a diam. of 4mm in 20 d in 2% malt extract agar (HiMedia, India), mycelium white, floccose, becoming cottony after 12 days in diurnal light at 22–24°C. As on the natural substrate, sporodochia in culture are superficial, scattered or in groups of 2–3, dark green to greenish black, 200–235 diam. × 150–160 µm high. Setae numerous, unbranched, hyaline, smooth, thick-walled, verrucose at the swollen base, blunt to rounded at the tip, septate, cells with reduced lumen, 110–190 µm long, 6–6.5 µm wide. Conidiophores integrated, subhyaline, verrucose, septate, penicillately branched, 75–95 × 2.0–8.5 µm. Conidiogenous cells integrated, monophialidic, verruculose, subhyaline, 8–14.5 × 2 µm, with conspicuous collarette and moderate periclinal thickening at the tip. Conidia fusiform-ellipsoidal with an acute apex, unicellular, subhyaline (in mass olivaceous-green), smooth, 6.5–8.5 × 2.5–3.5 µm, with a funnel-shaped, cupulate, mucoid, hyaline, 2–3 µm wide appendage.

Discussion

The genus *Lomachashaka* Subram., typified by *L. kera* (Subramanian 1956), is characterized by sporodochial, setose conidiomata, smooth or verrucose conidiophores, phialidic conidiogenesis and fusiform-ellipsoidal conidia with an apical, cupulate, mucoid appendage. Our new species *L. gomaya* is compared with the four hitherto known species in the genus (TABLE 1). The new species is characterized by long setae with a verrucose bulbous base, verrucose conidiophores, and small conidia. The conidial size of the novel species overlaps with that *L. africana*, but the species are distinctly different in their others characters. The coprophilous habit of *L. gomaya* also distinguishes it from the plant substrates, especially monocots, colonized by the other species.



FIGURES 1–7. *Lomachashaka gomaya*.

A. Conidiomata. B. Conidiogenous cells. C. Conidiophores. D. Seta. E–F. Conidia.

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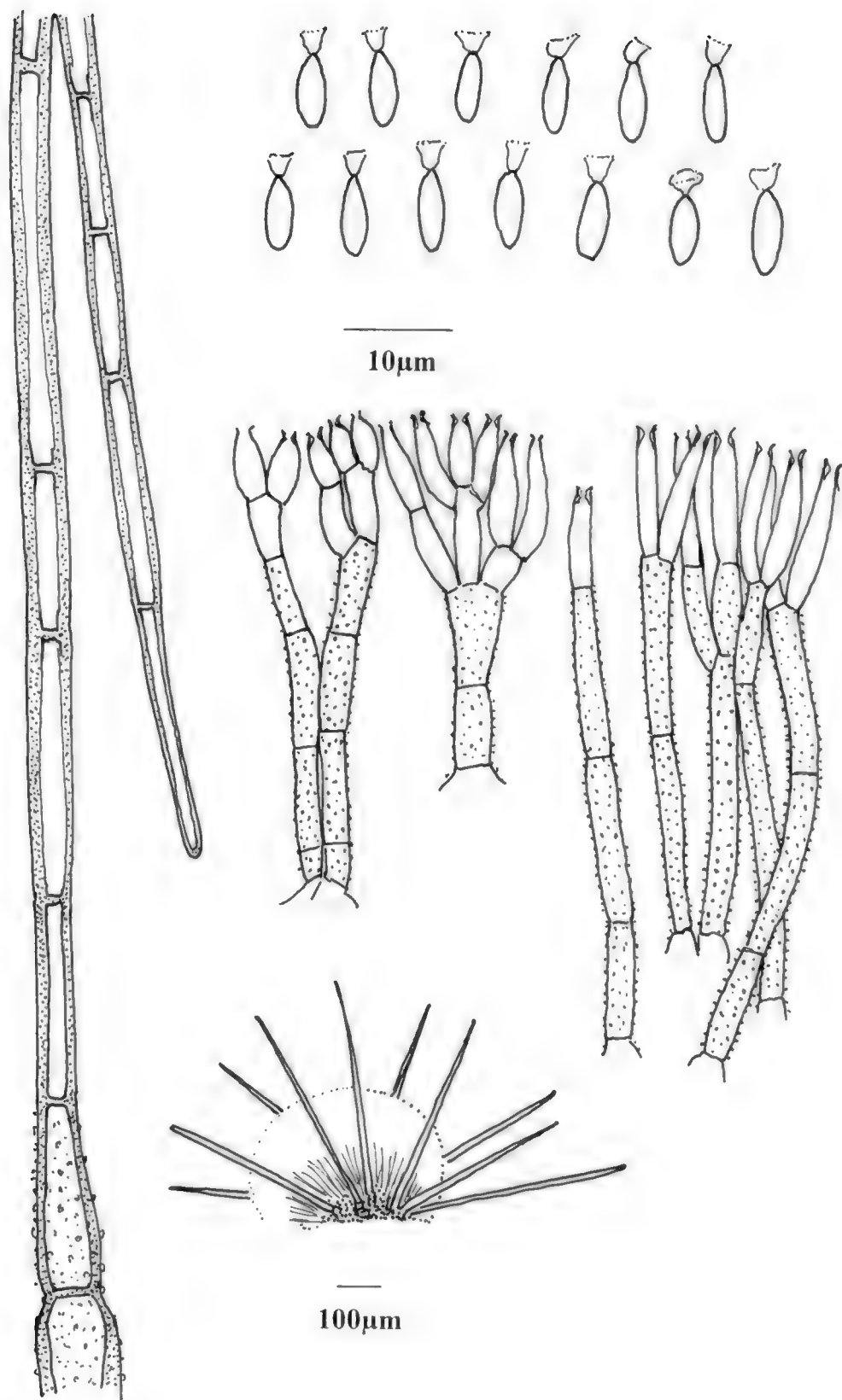


FIGURE 8. *Lomachashaka gomaya*.
Seta, Conidia, Conidiophores and conidiogenous cells, Conidioma.

References

Nag Raj TR. 1995. *Lomachashaka* revisited. Mycotaxon. 53: 311–324.
Subramanian CV. 1956. Hyphomycetes I. J. Indian Bot. Soc. 35(1): 53–91.

TABLE 1: Comparison of *Lomachashaka gomaya* with four known species

CHARACTERS		SUBSTRATE (LOCALITY)	CONIDIOMATA	SETAE	CONIDIOPHORES [all branched]	CONIDIOGENOUS CELLS	CONIDIA [apices funnel- shaped & mucoid]
SPECIES / (REFERENCE)							
<i>L. africana</i> Nag Raj (Nag Raj 1995)		Leaves of <i>Pennisetum purpureum</i> (Togoland)	Applanate to discoid; 140–200 × 30–40 µm	Filiform, flexuous; base bulbous, thick-walled, smooth; apex 70–160 µm long	Compact, smooth, hyaline to pale olivaceous	Subcylindrical to lageniform, flared collarette & mod. periclinal thickenings, pale olivaceous, 7–11 × 2–3 µm, twice percurrently proliferating, smooth	Fusiform, 6–9.5 × 2–2.5 µm
<i>L. cynodontis</i> Nag Raj (Nag Raj 1995)		Leaves of <i>Cynodon dactylon</i> (Ghana)	Aplanate to discoid; orbicular to oval, 160–220 × 40–80 µm	Base ampulliform to conical, smooth, 7–12 × 3.5–4.5 µm, separate from irreg. nodulose part; apex thick-walled, smooth, 50–140 µm long	Compact, smooth, hyaline to pale olivaceous	Vase-shaped with walls invaginated near median, with flared collarette & mod. periclinal thickenings, percurrently proliferating 1–2 times, smooth	Fusiform, pale olivaceous, smooth, 7–12.5 × 0.5–3.5 µm
<i>L. gomaya</i> (Present study)		Cattle dung (India)	Cupulate; 200–235 × 150–160 µm	Erect, unbranched, hyaline, smooth, with swollen, verrucose base, blunt at the tip, septate, 110–190 × 6–6.5 µm	Compact, verrucose, septate, sub hyaline to olivaceous	Mostly smooth, occ. minutely verrucose, subhyaline, phialidic, conspicuous collarette & mod. periclinal thickenings at the tip, 8–14.5 × 2 µm	Fusiform, smooth, hyaline, unicellular, olivaceous, 6.5–8.5 × 2.5–3.5 µm
<i>L. kera</i> Subram. (Subramanian 1956)		Dead leaves of <i>Cocos nucifera</i> (India)	Cupulate; 210–350 × 80–100 µm	Erect, thin-walled, hyaline, erect or flexuous, ≤ 200 × 1.5–2.5 µm	Compact, smooth, hyaline	Subcylindrical to lageniform, colourless, 13–19 × ≤ 3 µm	Fusiform, colourless, 9–14 × 2–4 µm
<i>L. sundara</i> Nag Raj (Nag Raj 1995)		Grass blades (India)	Pulvinate to discoid, cupulate, orbic. to oval; 100–180 × 60–100 µm	Base septate, verruculose, swollen, 15–20 × 2.5–3.5 µm; apex slender, thick- walled, irreg. nodulose, smooth, 120–300 µm	Smooth, hyaline	Subcylindrical to lageniform with flared collarette & marked periclinal thickenings, pale olivaceous, smooth, 9–15 × 2.5–3 µm	Fusiform or fus.-elliptic, pale olivaceous, smooth, 7–12.5 × 2.5–3.5 µm

Muscodor yucatanensis*, a new endophytic ascomycete from Mexican chakah, *Bursera simaruba

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Abstract — During a study on the fungal endophytic associations with some trees of the secondary forest of El Eden Ecological Reserve located in the northeastern Yucatan Peninsula of Mexico, a new fungal species was isolated as an endophyte of a tree named chakah, chachah, or hukúp (*Bursera simaruba*) by indigenous Mayas. This fungus is characterized by producing a strong musty odor and absence of reproductive structures. Cultures of this fungus on PDA form a whitish, flocculose colony with an uncolored reverse and a mycelium that grows slowly. Scanning electron microscopy photographs showed in aerial and submerged mycelium the early formation of unique intercalary swollen, thin-walled, rugulose hyphae. Based on morphological and DNA sequence analyses, the Mexican isolate is a member of the *Xylariales* with high similarity to *Muscodor albus* and the related species *Muscodor vitigenus*, but with distinct differences that is here described and illustrated as *Muscodor yucatanensis* sp. nov.

Key words — angiospermous trees, *Burseraceae*, fungal biodiversity, taxonomy, tropical forests

Introduction

The description of *Muscodor*, an endophytic ascomycete genus, constitutes a valuable contribution to our knowledge of fungal biodiversity (Worapong et al. 2001). *Muscodor* species produce a mixture of volatile organic compounds with strong biological activity against bacteria, fungi, and insects (Daisy et al. 2002a, Grimme et al. 2007, Mercier & Smilanick 2005, Ramin et al. 2007, Stinson et al.

2003, Strobel et al. 2001). The type species, *M. albus* was originally described from branches of *Cinnamomum zeylanicum* from Honduras (Worapong et al. 2001). Shortly thereafter, *M. roseus* was isolated from *Grevillea pteridifolia* and *Erythrophleum chlorostachys* from Northern Territory of Australia (Worapong et al. 2002), *M. vitigenus* was obtained from *Paullinia paullinioides* from the Peruvian Amazon rainforest (Daisy et al. 2002b), and *M. crispans* was recorded from *Ananas ananassoides* from the Bolivian Amazon basin (Mitchell et al. 2008). The exploration of tropical ecosystems to discover new fungi for bioprospecting has resulted in new records of *M. albus* from different plants from Thailand (Sopalun et al. 2003), Northern Territory of Australia (Ezra et al. 2004), Indonesia (Atmosukarto et al. 2005), and Ecuador (Strobel et al. 2007). Because *Muscodor* species do not form reproductive structures and their 5.8S rDNA sequences are highly similar, species in this genus have been described based on detailed analyses of colonies, hyphal morphology, and the chemical structure of volatile compounds (Seifert et al. 1995, Taylor et al. 1999). In this work, a new species *M. yucatanensis* is proposed.

Materials and methods

Study area and sample collection

The Eden Ecological Reserve is located in the State of Quintana Roo in the northeastern part of the Yucatan Peninsula of Mexico, at 21°36'–20°34'N and 87°06'–87°45'W. The tree *Bursera simaruba* (L.) Sarg. (*Burseraceae*) is 35 m tall and its fruit, flower, leaf, and bark are used by indigenous Mayas to treat snakebites, skin mycoses, fever, and diarrhea because of its anti-inflammatory, analgesic, antibacterial, and antifungal capabilities (Gómez-Pompa et al. 2003). Host trees were randomly selected and separated from one another by approximately 50 m. Four asymptomatic, healthy mature leaves (6 mo old) from each of three *Bursera simaruba* individuals were collected and transported to the laboratory in sterile Zip-lock® plastic bags and processed within one hour of collection.

Endophytic fungus isolation, description, and preservation

In the El Eden Ecological Reserve laboratory the collected leaves were washed in running sterile distilled water for 60 sec. Each washed leaf was cut into 2 × 2 mm segments with sterile scissors. Leaf segments were surface-sterilized by sequential washes in 0.525% sodium hypochlorite (2 min) and 70% ethanol (2 min), rinsed with sterile distilled water, and then surface-dried under sterile conditions (Arnold et al. 2001). Eight sterilized segments were plated on MEA (agar 20 g, malt extract 20 g, distilled water 1L) supplemented with 4 g/L streptomycin sulfate and 5 mg/L Cyclosporine A (Dreyfuss 1986). Five Petri dishes were prepared for each leaf, incubated under lab conditions, and checked daily for 4 wks. Fourteen morphologically different isolates were obtained. Among the fungi recovered was isolate B110, which showed strong inhibition and produced a musty odor. This fungus did not produce spores on different test media even with added sterilized bark and leaves from *B. simaruba*. The morphology of this fungus was examined using light microscopy, fluorescent microscopy, and scanning electron

microscopy (Goh & Hanlin 1994). For fluorescent microscopy, fungal cells walls were stained with 0.1% w/v calcofluor (Sigma) (Kuck et al. 1981). For preservation, a living culture of this fungus was stored in liquid nitrogen vapor in cryoprotectant (10% v/v) glycerol in distilled water. Culture was deposited in the Herbario Nacional (MEXU).

DNA sequence analyses

The internal transcribed spacer (ITS1-5.8S rDNA-ITS2) region of nuclear ribosomal DNA from strain B110 was amplified and sequenced using primers ITS5 and ITS4 and analyzed as previously described (Glenn et al. 1996). Sequencing was performed by the United States Department of Agriculture–Agricultural Research Service South Atlantic Area Sequencing Facility (Athens, GA, USA). The DNA sequence was deposited in GenBank (www.ncbi.nlm.nih.gov) as accession FJ917287. ClustalW2 (<http://www.ebi.ac.uk/Tools/clustalw2/>) was used to generate a DNA sequence alignment between strain B110 and other GenBank accessions. Distance-based analysis of the ITS sequence alignment was performed using MEGA 4.1 with the following settings: Kimura 2-parameter model, neighbor-joining algorithm, pairwise deletion of gaps and missing data, and 1000 bootstrap replications.

Results

Taxonomic description

Muscodor yucatanensis M.C. González, Anaya, Glenn & Hanlin, **anam. sp. nov.**

MYCOBANK # 513288, GENBANK # FJ917287

FIGURES 1–11

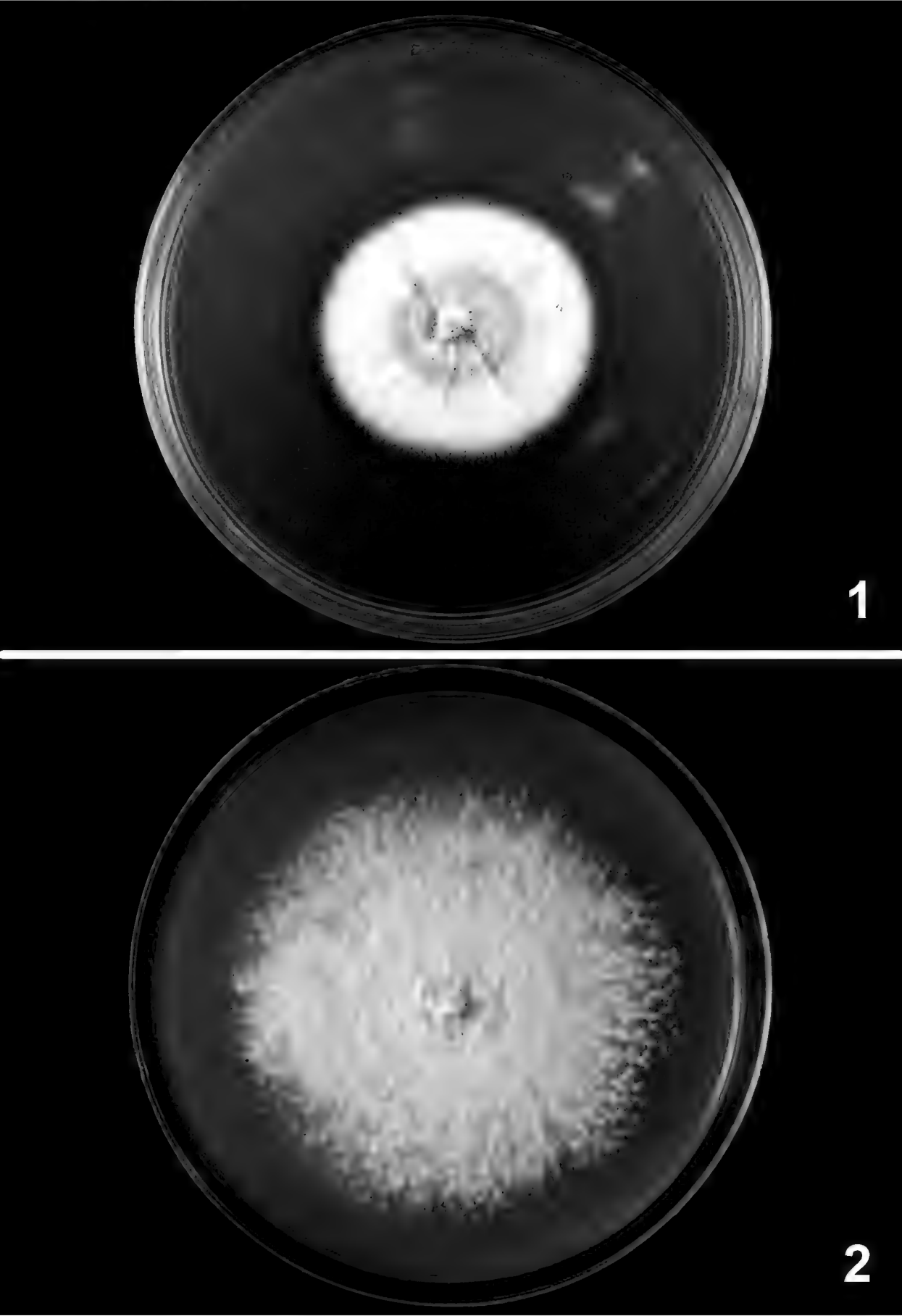
COLONIAE in agar decoto tuberorum (PDA), lente crescentes, ad 30–35 mm diametro attingentes in 14 diebus ad 25°C, albo-flocculosae, odorem mucidum proprie producens. Mycelium sterilibus, ex asexual et sexual spora vel sporiferus structura ignota. Coloniae vetius (60 diebus), eborinus, aversa parte incolorata, paulo funiculosae. Hyphae hyalinae, leptodermica, rugulosae, septatae, 0.5–4 µm diametro, saepe ramificatione in angulis 90° plerumque, convolventes, fila funiformia 2–20 µm diametro et spiras formantes 10–40 µm diametro, mox vesicula subglobosa intercalaribus numerosa efficientibus.

TELEOMORPHA ignota. Data sequentia regionis ITS (ITS1-5.8S rDNA-ITS2) *Muscodor yucatanensis* (GenBank accession # FJ917287) affinitatem Xylariales suggerunt.

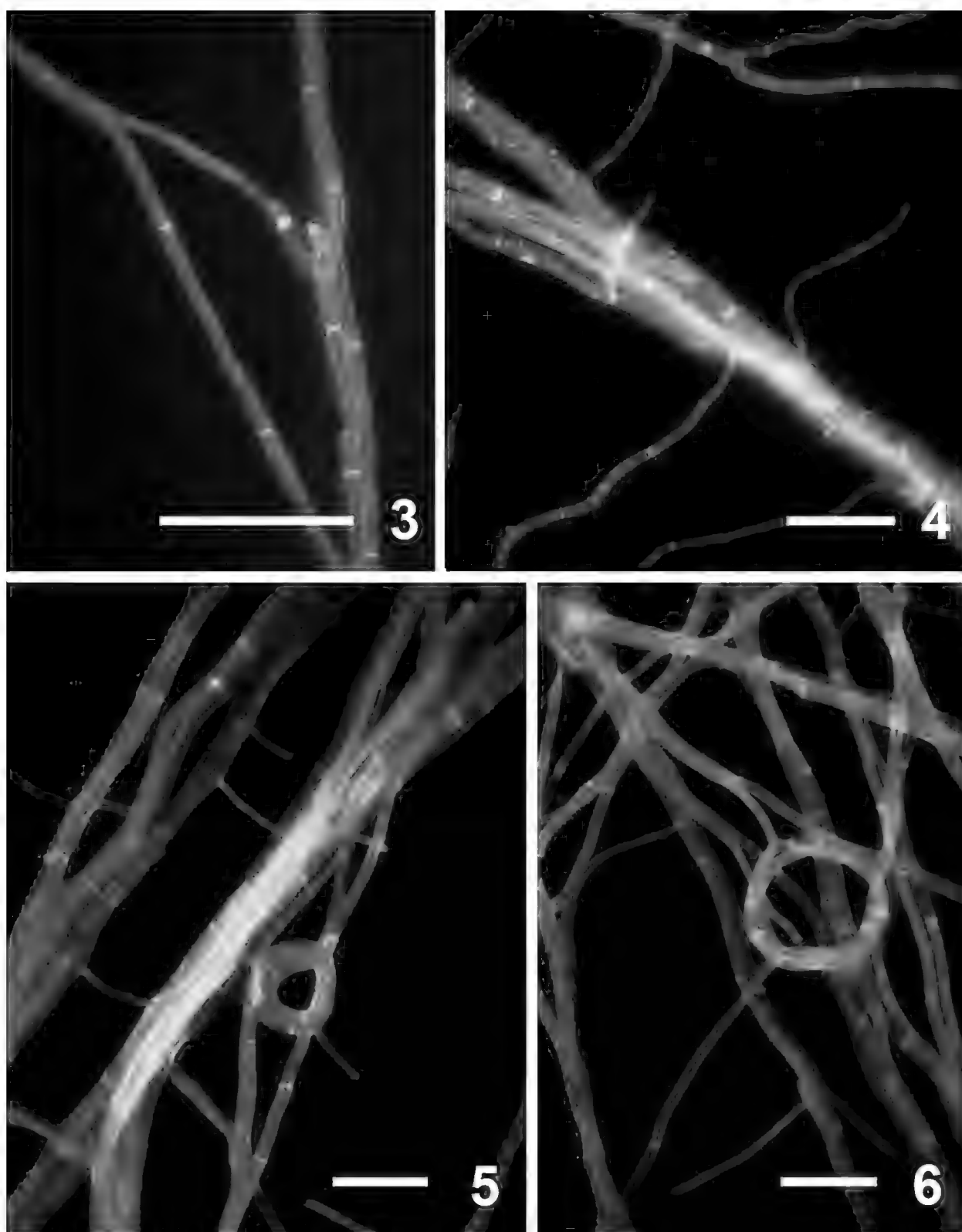
HOLOTYPE: MEXICO. Quintana Roo: Isla Mujeres Municipality, El Eden Ecological Reserve (21°13'N 87°11'W), from leaves of *Bursera simaruba*, May 2004, MC González, AL Anaya. MEXU 25511.

ETYMOLOGY: The epithet *yucatanensis* refers to the Peninsula of Yucatan, Mexico.

COLONIES on potato dextrose agar (PDA), slowly growing, attaining 30–35 mm diam in 14 d at 25°C, whitish, flocculose and characteristically producing a strong musty odor (FIG. 1). Mycelium sterile, asexual and sexual spores and sporiferous structures unknown. Older colonies (60 days) ivory-white, reverse uncolored, slightly funiculose (FIG. 2). Hyphae hyaline, thin-walled, rugulose, septate, 0.5–4 µm diam, frequently developing by 90° angle branching, intertwining and forming rope-like strands 2–20 µm diam (FIGS. 3, 4, 10) and coils 10–40 µm diam, (FIGS. 5, 6, 9) soon forming numerous intercalary subglobose vesicles.

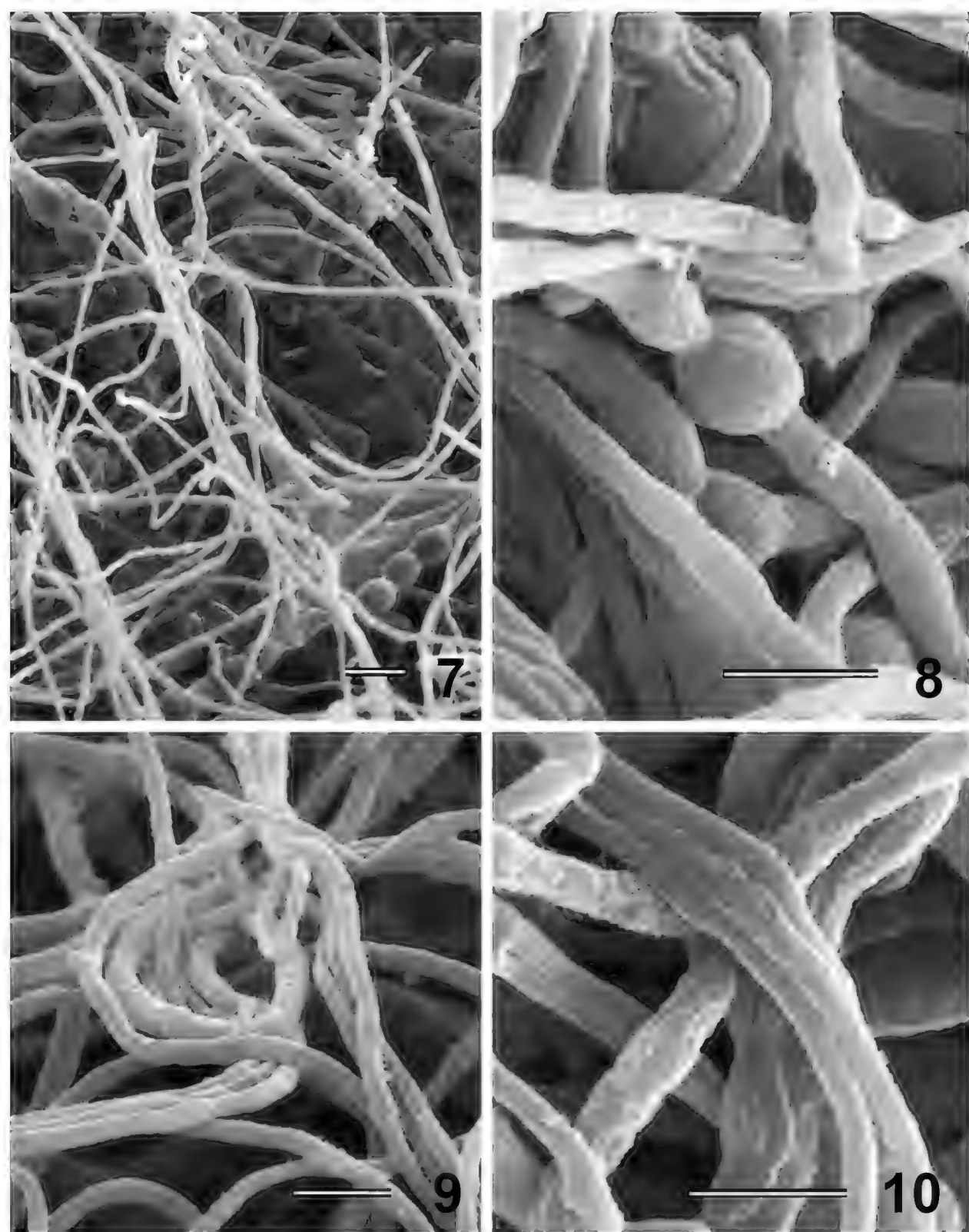


FIGS. 1–2. *Muscodor yucatanensis*. 1. Colony appearance on PDA after 14 days at 25°C. 2. Colony appearance on PDA after 60 days at 25°C.



FIGS. 3–6. *Muscodor yucatanensis*. 3–4. Septate hyphae, showing variation in width, rope-like strands, and intertwining hyphae. 5–6. Rope-like strands and hyphal coil formation. All photomicrographs taken with fluorescent microscopy. Bars = 20 μ m.

TELEOMORPH unknown. Sequence data of the ITS regions (ITS1–5.8S rDNA–ITS2) regions of *Muscodor yucatanensis* (GenBank accession # FJ917287) suggest a relationship to *Xylariales*.



FIGS. 7-10. *Muscodor yucatanensis*. 7. Hyphae at surface of colony showing the characteristic swollen cells. 8. Detail of swollen hypha. 9. Hyphal coil formation. 10. A rope-like strand of rugulose hyphae. All photomicrographs taken with scanning electron microscopy. Bars = 5 μ m.

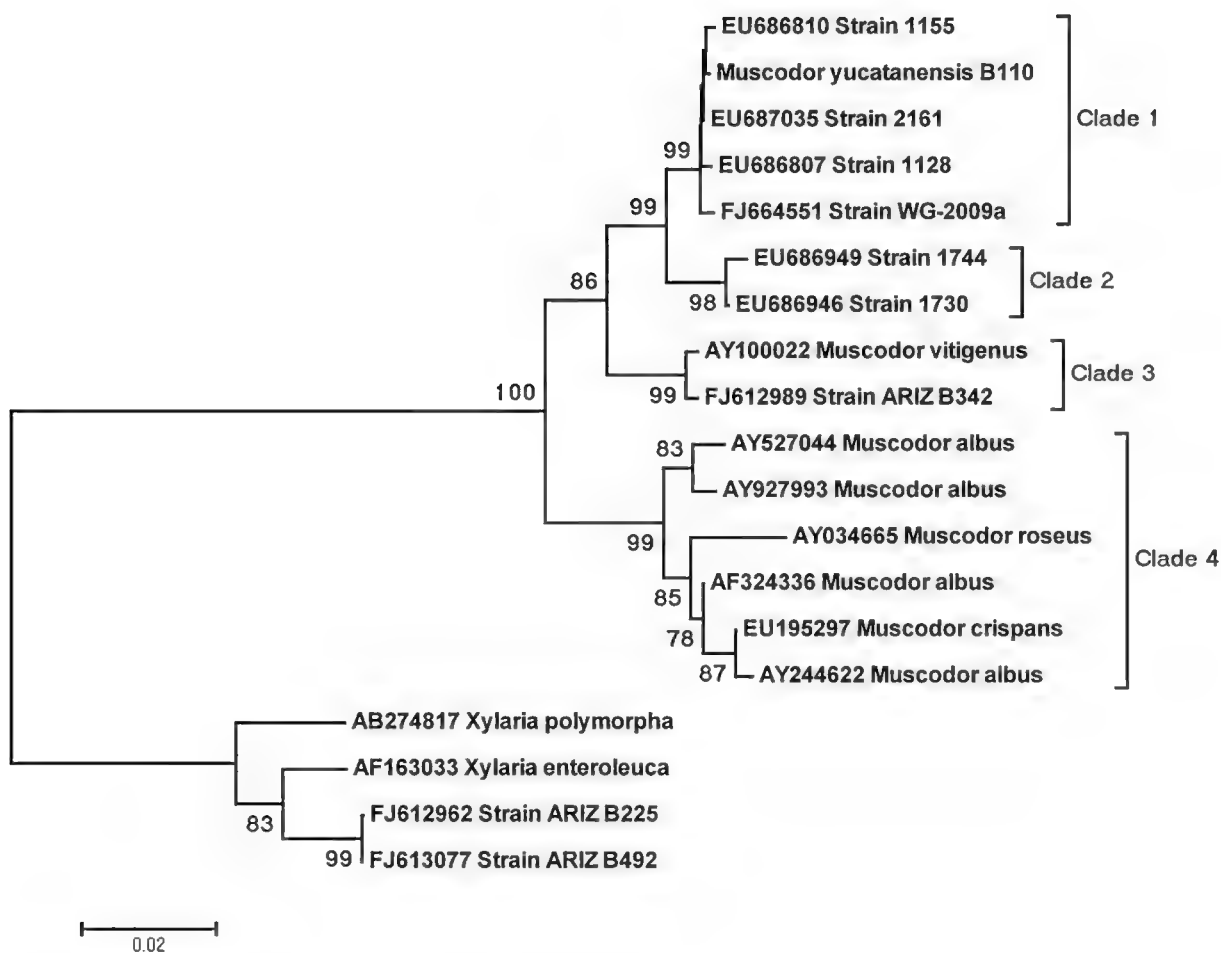


FIG. 11. *Muscodor yucatanensis*. Neighbor-joining analysis of aligned ITS rDNA sequences from *Muscodor* species. (Kimura 2-parameter; pairwise deletion). Bootstrap values (1000 replications) are indicated for well-supported clades. All sequences were obtained from GenBank accessions (numbers indicated) except for *M. yucatanensis* strain B110, which we sequenced. Four clades were evident within the *Muscodor* lineage, and these clades appear to correspond to different species. The phylogram is rooted to the *Xylaria* clade, which contains the unidentified endophyte isolates ARIZ B225 and ARIZ B492.

Sequence analyses

Nucleotide-nucleotide BLAST (megablast) query using the 610 bp amplicon sequence against the GenBank nucleotide collection database suggested strain B110 was a member of the *Xylariales* with very high similarity to *Muscodor albus*. Representative ITS accessions of *Muscodor* species and unidentified endophytes were used to determine possible phylogenetic relationships (FIG. 11). Strain B110 clustered in Clade 1 with other unidentified endophytes (99% bootstrap support). This clade is herein recognized as the new species *Muscodor yucatanensis*. Clade 2 includes two unidentified endophytes that also may represent an undefined species (98% bootstrap). Clade 3 includes the previously defined *Muscodor vitigenus* clustering with an unidentified endophyte (99% bootstrap). Lastly, Clade 4 consists of three species, *M. albus*, *M. crispans*, and *M. roseus* (99% bootstrap). Strains ARIZ B225 and ARIZ B492

had identical ITS sequences and represent an unidentified endophyte that here serves as a sister taxon to the delineated *Muscodor* species.

Discussion

Tropical ecosystems probably have a higher biological and functional fungal diversity compared to other climates (Hyde 1997). *Muscodor* is essentially a genus of endophytic, tropical fungi. Its diversity and host range is gradually being revealed as additional hosts and habitats are explored. Species of this genus are found in all tropical regions in Central and South America, South Eastern Asia, and Australia (Worapong et al. 2002, Daisy et al. 2002b, Mitchell et al. 2008, Sopalun et al. 2003, Ezra et al. 2004, Atmosukarto et al. 2005, Strobel et al. 2007). The characteristic mixture of volatile compounds produced by each *Muscodor* species suggests adaptation to a unique ecological role in its respective ecosystem. *Muscodor vitigenus* forms only naphthalene in high concentration, which protects *Paullinia paullinioides* from insects, while different mixtures of volatile compounds produced by *M. albus* or *M. roseus* have a strong and specific activity against a select group of fungi or unique fungal species. For this reason, *M. albus* and *M. vitigenus* were described as different species based on the differences in volatile compounds that they produced. The morphologies of *Muscodor* species show some differences. *Muscodor albus* persistently develops whitish mycelium under light or dark conditions and different media compositions, while *M. crispans* develops pinkish mycelium under light and whitish mycelium under dark conditions; *M. roseus* produces a dense, lightly rose colored mycelium in different media and environmental conditions. Also, hyphal morphology is an additional phenotypical character used to delimit *Muscodor* species. Although *M. albus* and *M. vitigenus* form whitish mycelia, the hyphae of *M. albus* are smaller (1.1–1.7 μm) in diameter than those of *M. vitigenus* (0.7–2.1 μm). *Muscodor crispans* (0.6–2.7 μm diam) forms characteristic undulating hyphae with cauliflower-like structures.

One hundred and six leaf fragments (22%) developed fungal growth and 12 morphologically different isolates were recovered from four leaves of *Bursera simaruba* from the Yucatan Peninsula. Of them, the B110 isolate, which showed strong antifungal activity, was selected for further study. The Mexican isolate on PDA forms a white, flocculose, radially sulcate colony with an entire margin and uncolored reverse with hyaline, rugulose, thin-walled, septate, 90° angle branching hyphae that intertwine and form rope-like strands and coils; it does not form asexual and sexual spores and sporiferous structures. In aerial and submerged mycelium, scanning electron micrographs showed the early formation of unique intercalary swollen, thin-walled hyphal cells. In addition, the fungus from the Yucatan Peninsula produces a distinctive mixture of bioactive volatile compounds and does not form naphthalene (data not shown).

The ITS rDNA sequence data of strain B110 suggested it belongs in *Muscodor* (*Xylariales*) and showed similarity to *M. albus* and *M. vitigenus*.

Although the Mexican fungus isolate B110 characteristics agree with the generic description of *Muscodor*, the possession of unique intercalary swollen thin-walled hyphae, the wider (0.5–4 μm) hyphal diameters, and its rugulose wall, the entire margin of the radially sulcate colonies, the endophytic habit in *B. simaruba* (*Burseraceae*) from medium semideciduous dry tropical forest of the Yucatan Peninsula, the production of new mixture of volatile compounds that does not include naphthalene, and its distinct phylogenetic lineage separate from *M. albus* and *M. vitigenus* all support *Muscodor yucatanensis* as representing an independent new species.

Acknowledgments

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Literature cited

- Arnold AE, Maynard Z, Gilbert GS. 2001. Fungal endophytes in dicotyledonous neotropical trees: patterns of abundance and diversity. *Mycol Res* 105: 1502–1507.
- Atmosukarto I, Castillo U, Hess WM, Sears J, Strobel G. 2005. Isolation and characterization of *Muscodor albus* I-41.3s, a volatile antibiotic producing fungus. *Plant Sci* 169: 854–861.
- Daisy B, Strobel GA, Castillo U, Ezra D, Sears J, Weaver DK, Runyon JB. 2002a. Naphthalene, an insect repellent, is produced by *Muscodor vitigenus*, a novel endophytic fungus. *Microbiology* 148: 3737–3741.
- Daisy B, Strobel G, Ezra D, Castillo U, Baird G, Hess WM. 2002b. *Muscodor vitigenus* anam. sp. nov., an endophyte from *Paullinia paullinioides*. *Mycotaxon* 84: 39–50.
- Dreyfuss MM. 1986. Neue Erkenntnisse aus einem pharmakologischen Pilzscrening. *Sydowia* 39: 22–36.
- Ezra D, Hess WM, Strobel GA. 2004. New endophytic isolates of *Muscodor albus*, a volatile-antibiotic-producing fungus. *Microbiology* 150: 4023–4031.
- Glenn AE, Bacon CW, Price R, Hanlin RT. 1996. Molecular phylogeny of *Acremonium* and its taxonomic implications. *Mycologia* 88: 369–383.
- Goh TK, Hanlin RT. 1994. Ascomal development in *Melanospora zamiae*. *Mycologia* 86: 357–370.
- Gómez-Pompa A, Allen MF, Fedick SL, Jiménez-Osornio JJ. 2003. The lowland Maya area. Three millennia at the human-wildland interference. Food Products Press, New York.
- Grimme E, Zidack NK, Sikora RA, Strobel GA, Jacobsen BJ. 2007. Comparison of *Muscodor albus* volatiles with a biorational mixture for control of seedling diseases of sugar beet and root-knot nematode on tomato. *Plant Dis* 91: 220–225.
- Hyde KD. 1997. Biodiversity of tropical microfungi. Hong Kong University Press, Hong Kong.

- Kuck KH, Tiburzy R, Hänssler G, Reeisener HJ. 1981. Visualization of rust haustoria in wheat leaves by using fluorochromes. *Physiol Plant Pathol* 19: 438–441.
- Mercier J, Smilanick JL. 2005. Control of green mold and sour rot of stored lemon by biofumigation with *Muscodor albus*. *Biol Control* 32: 401–407.
- Mitchell AM, Strobel GA, Hess WM, Vargas PN, Ezra D. 2008. *Muscodor crispans*, a novel endophyte from *Ananas ananassoides* in the Bolivian Amazon. *Fungal Diversity* 31: 37–43.
- Ramin AA, Prange RK, Gordon-Braun P, DeLong JM. 2007. Biofumigation of postharvest fungal apple decay with *Muscodor albus* volatiles. *J Appl Sci Res* 3: 307–310.
- Seifert KA, Wingfield BD, Wingfield MJ. 1995. A critique of DNA sequence analysis in the taxonomy of filamentous ascomycetes and ascomycetous anamorphs. *Can J Bot* 73: 760–767.
- Sopalun K, Strobel GA, Hess WM, Worapong J. 2003. A record of *Muscodor albus*, an endophyte from *Myristica fragrans*, in Thailand. *Mycotaxon* 88: 239–247.
- Stinson AM, Zidack NK, Strobel GA, Jacobsen BJ. 2003. Effect of mycofumigation with *Muscodor albus* and *Muscodor roseus* on seedling diseases of sugarbeet and *Verticillium* wilt of eggplant. *Plant Dis* 87: 1349–1354.
- Strobel GA, Dirkse E, Sears J, Markworth C. 2001. Volatile antimicrobials from *Muscodor albus*, a novel endophytic fungus. *Microbiology* 147: 2943–2950.
- Strobel GA, Katreena K, Hess WM, Sears J, Ezra D, Vargas PN. 2007. *Muscodor albus* E-6, an endophyte of *Guazuma ulmifolia* making volatile antibiotics: isolation, characterization and experimental establishment in host plant. *Microbiology* 153: 2613–2620.
- Taylor JW, Jacobson DJ, Fisher MC. 1999. The evolution of asexual fungi: reproduction, speciation and classification. *Annu Rev Phytopathol* 37: 197–246.
- Worapong J, Strobel GA, Ford EJ, Li JY, Baird G, Hess WM. 2001. *Muscodor albus* anam. nov., an endophyte from *Cinnamomum zeylanicum*. *Mycotaxon* 79: 67–79.
- Worapong J, Strobel GA, Daisy B, Castillo U, Baird G, Hess WM. 2002. *Muscodor roseus* anam. nov., an endophyte from *Grevillea pteridifolia*. *Mycotaxon* 81: 463–475.

Studies in lichens and lichenicolous fungi: more notes on taxa from North America

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Abstract — The following taxa are reported for the first time from North America: *Arthonia anglica*, *A. cyrtodes*, and *Lichenostigma anatolicum*. *Sarcogyne bolleana* is made a synonym of *S. arenosa*.

1. *Arthonia anglica* Coppins, *Lichenologist* 21(3): 195. 1989.

TYPE: Anglia, “St. Leonard’s, Jan. 1806”, ad corticem *Fagi*, ?*W. Borrer* s.n.
(BM, holotype).

Arthonia “dryadum” R.C. Harris & Ladd ined., Preliminary Draft, Ozark Lichens, p. 59. 2005.

Harris & Ladd (2005) were the first to recognize the occurrence of this *Arthonia* species on the bark of hardwoods (especially *Acer* and *Carpinus*) in humid mesic woodlands along streams in the Ozarks. They noted that their material was similar to *A. anglica* but chose not to take up the name because they had not seen comparative material of that species and instead opted to use the manuscript name *A. “dryadum”*. While conducting fieldwork in the Ozark Ecoregion, the first author (JCL) became acquainted with this species and subsequently found populations in the middle to low elevations of the southern Appalachian Mountains (Lendemer & Tripp 2004) where it occurred in habitats comparable to those of the Ozark populations. Further fieldwork in southeastern North America revealed the species to be widespread in the coastal plain and piedmont (Hansen et al. 2008, Perlmutter & Lendemer 2008). In light of the Appalachian-Ozark distribution of this taxon in eastern North

America, a distribution that almost certainly indicates a wider distribution in the past, the first author was prompted to send a specimen of *A. "dryadum"* to Brian Coppins (E), who compared it to material of *A. anglica* and confirmed that they are conspecific. Thus, *A. anglica* is reported here for the first time from North America. *Arthonia anglica* can be distinguished from other North American species of *Arthonia* by its corticolous habit, irregularly shaped reddish-brown ascomata that contain gyrophoric acid in the margins, (3–)4-celled macrocephalic ascospores ($15\text{--}22 \times 5\text{--}7 \mu\text{m}$), and *Trentepohlia* photobiont.

SELECTED SPECIMENS EXAMINED. – **U.S.A. Alabama.** ESCAMBIA CO.: Little River State Forest, W of SR 21, 12.iv.2007, *J.C. Lendemer et al.* 9251 (NY). **Arkansas.** BENTON CO.: Hobbs State Park-Conservation Area, 16.x.2005, *J.C. Lendemer et al.* 5617 (NY). CRAWFORD CO.: Ozark National Forest, along FSR 1725, 15.iv.2004, *R.C. Harris* 49159 (NY). NEWTON CO.: Buffalo National River, along CR 84, 17.iv.2005, *R.C. Harris* 51051-A (NY). **Georgia.** TOWNS CO.: Southern Nantahala Wilderness, Hightower Gap to Rich Knob, 11.xi.2007, *J.C. Lendemer et al.* 10914 (NY). **Missouri.** BUTLER CO.: Mark Twain National Forest, Mud Creek Natural Area, 16.x.2003, *W.R. Buck* 45442 (NY). CARTER CO.: Peck Ranch Conservation Area, 16.iv.1997, *W.R. Buck* 31813 (NY). GREENE CO.: Rocky Barrens Conservation Area, 16.iv.2005, *R.C. Harris* 50929 (NY). IRON CO.: Mark Twain National Forest, along CR N, 13.x.1993, *R.C. Harris* 31154-A (NY). JEFFERSON CO.: E of Don Robinson Rd., 12.x.2003, *R.C. Harris* 48156 (NY). MADISON CO.: Mark Twain National Forest, Rock Pile Mountain Wilderness Area, 14.x.2003, *R.C. Harris* 48281 (NY). MORGAN CO.: Frank E. Carpenter Memorial Conservation Area, 15.iv.2005, *W.R. Buck* 48579 (NY). OREGON CO.: Mark Twain National Forest, Greer Spring Trail, 18.x.2003, *R.C. Harris* 48747-A (NY). RIPLEY CO.: Mudpuppy Conservation Area, 17.x.2003, *R.C. Harris* 48632 (NY). TANEY CO.: Mark Twain National Forest, Hercules Glades Wilderness, 22.v.2003, *R.C. Harris* 47746 (NY). WAYNE CO.: Sam A. Baker State Park, 15.x.2003, *R.C. Harris* 48374 (NY). **North Carolina.** CARTERET CO.: Cape Lookout National Seashore, Shackleford Banks, 19.iii.2003, *W.R. Buck* 43808 (NY). HAYWOOD CO.: Great Smoky Mountains National Park, 3 mi SE Waterville, 28.x.2006, *J.C. Lendemer* 8159 & *E. Tripp* (NY). JONES CO.: Croatan National Forest, Catfish Lake South Wilderness, 17.iii.2003, *R.C. Harris* 47085 (NY). ORANGE CO.: Mason Farm Biological Preserve, 13.iv.2007, *G.B. Perlmutter et al.* 917 (NY). TRANSYLVANIA CO.: Gorges State Park, E facing drainage of the Toxaway River, 10.viii.2005, *J.C. Lendemer* 5641 & *E. Tripp* (NY). WAKE CO.: William B. Umstead State Park, 13.i.2007, *J.C. Lendemer et al.* 8314 (NY). **Virginia.** WYTHE CO.: Jefferson National Forest, Mt. Rogers National Recreation Area, Raven Cliff Horse Camp, 6.iv.2008, *G.B. Perlmutter* 1350 (NY). **Wisconsin.** COLUMBIA CO.: Columbia Power Plant, 11.ix.2003, *S. Will-Wolf s.n.* (NY).

2. *Arthonia cyrtodes* Nyl., Annal. Sci. Nat. Bot., ser. 4, 19: 351. 1863.

TYPE: Cuba, *C. Wright s.n.* = *Lichenes Cubae* no. 245 (FH-TUCK #3726! [HUH barcode 00259864, left-hand specimen marked "1"], lectotype designated here).

Arthothelium cyrtodes (Nyl.) Zahlbr., Cat. Lich. Univers. 2: 123. 1922.

Arthonia cyrtodes is a conspicuous member of the morphologically diverse and remarkably speciose genus *Arthonia* Ach. The species was described from Cuba, and the herbarium of The New York Botanical Garden (NY) holds additional

collections from Puerto Rico. This is the first report of the species from North America.

The history and typification of the name *Arthonia cyrtodes* require some discussion because it has been placed in the genus *Arthothelium* A. Massal. despite having transversely septate ascospores. When Nylander (1863) described *Arthonia cyrtodes* he based it on “*Lecidea cyrtodes* Tuck.” a manuscript name supplied by Edward Tuckerman. In the description Nylander noted that the original material of Tuckerman’s name actually consisted of two taxa, one with transversely septate ascospores which he named *A. cyrtodes* and another with muriform ascospores which he named *A. distendens* Nyl. Thus it is clear from the protologue of *A. cyrtodes* that the name applies to a taxon with transversely septate ascospores. In his revision of the genus *Arthonia*, Willey (1890) organized all of the known *Arthonia* species into groups based on ascospore color and septation. For some reason he placed *A. cyrtodes* in the group that was characterized by hyaline muriform ascospores (Willey 1890: 50) despite the fact that his own description did not report longitudinal septa. It was presumably on this basis that Zahlbruckner (1922) incorrectly transferred *A. cyrtodes* to *Arthothelium*. *Arthonia cyrtodes* has not been typified and as such, to prevent any confusion as to the application of the name, a lectotype is selected here from amongst the original material sent by Tuckerman to Nylander.

In the field this species could easily be confused with several others that have white continuous thalli and large flattened reddish-black ascomata, namely *Arthonia macrotheca* Fée or *A. mesoleuca* Nyl. *Arthonia cyrtodes* is almost identical to the former taxon in having an oil inspersed hymenium, large ascospores (>50 µm long), and K– pigments in the epihymenium; it differs in having transversely septate (10–13-celled) rather than muriform ascospores. The latter taxon is only superficially similar to *A. cyrtodes*, and differs by having a hymenium that is not inspersed with oil droplets, shorter ascospores (<50 µm long) that are muriform, and K+ red-violet pigments in the epihymenium.

ADDITIONAL SPECIMENS EXAMINED. – Puerto Rico: vicinity of San Juan, 13.iii.1906, N.L. Britton 302 & W.M. Wheeler (NY); Santurce, 12.ii.1914, E.G. Britton 1478 (NY); Dorado, 13.ii.1914, N.L. Britton 1504 & J.F. Cowell (NY); Naranjito, 25.xi.1915, B. Fink 96 (NY). U.S.A. Florida. GLADES CO.: Ortona Cemetery, 6.iii.2009, J.C. Lendemer et al. 15722 (NY).

3. *Lichenostigma anatolicum* Halici & Kocakaya, Mycotaxon 108: 68. 2009.

TYPE: Turkey, Sivas, Gürün District, Gökpınar, 38°39.071’N, 37°18.309’E, alt. 1620 m, on thallus of a brown *Acarospora* sp. on gypsaceous rocks, 05.viii.2008, M. Kocakaya (hb. Erciyes University, Biology Department-0.5471, holotype).

Lichenostigma anatolicum is a newly described species collected on the thallus of a sterile brown *Acarospora* in Turkey (Halici et al. 2009). The species suppresses ascomata production in the host and is distinguished by the I+/KI+ blue

stain of the centrum and finely verruculose non-halonate brown ascospores (9.0–)9.2–10.5–11.8(–13) \times (5.0–)5.5–6.3–7.0(–7.5) μm . Though halonate ascospores were not seen in the type specimen from Turkey, we observed that young ascospores were halonate, the halo up to 4 μm wide. It is a member of the subgenus *Lichenostigma*, a group that does not produce superficial black hyphae on the host. Our specimen was collected on sterile *Acarospora* cf. *veronensis* areoles on sandstone in both shade and full sun in Fremont Canyon in the Santa Ana Mountains in southern California. *Lichenostigma anatolicum* was rare, but the whole canyon had recently burned and only a remnant of the lichen and lichenicolous fungi biota survived. If not abundant on the host, *L. anatolicum* can be easily overlooked.

There are currently 23 described species of *Lichenostigma* worldwide (Mycobank 2009). Including this record, 11 species of *Lichenostigma* have been reported from North America (Esslinger 2009, Knudsen & Kocourková 2008, Kocourková & Knudsen 2008).

SPECIMENS EXAMINED. – U.S.A. California. ORANGE CO.: Santa Ana Mountains, Fremont Canyon, south ridge, 33°47'24"N 117°40'19"W, 452 m, on *Acarospora* cf. *veronensis*, on sandstone slabs in shade above truck trail, 3.xii.2007, K. Knudsen 9266 (UCR); south ridge 33°47'35"N, 117°41'33"W, 490 m, on sterile brown *Acarospora* on sandstone outcrops on spur of ridge in full sun, 3.xii.2007, K. Knudsen 9272 (PRM).

4. *Sarcogyne arenosa* (Herre) K. Knudsen & S. Standley, *Opuscula Philolichenum*, 2: 36. 2005.

Acarospora arenosa Herre, *Proc. Wash. Acad. Sci.*, 12: 129. 1910.

TYPE: U.S.A., California, Santa Cruz Mountains, hills west of Stanford University, on sandstone, 11.vi.1904, A. Herre 540 (FH [HUH barcode 60874]!, lectotype; FH!, MIN!, US!, isolectotypes)

Syn. nov. *Sarcogyne bolleana* H. Magn., *Ann. Crypt. Exot.*, 7: 143. 1935.

TYPE: U.S.A., western part, 1879, J. Boll s.n. (G!, holotype).

At the time of writing the treatment of *Sarcogyne* for the Lichen Flora of the Greater Sonoran Desert Region, Knudsen & Standley (2008) believed the type of *Sarcogyne bolleana* was lost and treated *S. bolleana* as a synonym of *S. regularis* Körb. Recently P. Clerc located the holotype of *S. bolleana* at G, which had not been annotated by Magnusson. The type definitely represents *S. arenosa* and so we correct the synonymy here. For descriptions of *S. arenosa*, see Magnusson (1935, as *S. bolleana*) and Knudsen & Standley (2008).

Magnusson did not see the Herre types of *S. arenosa* from the Santa Cruz Mountains in central California, which were apparently not deposited at FH when he wrote his monograph on *Acarospora*. He did examine two specimens determined as *Acarospora arenosa* from the Santa Monica Mountains in southern California, probably collected by H.E. Hasse, which he identified as

S. regularis and *Myriospora heppii* (Nägeli ex Körb.) Hue (Magnusson 1929), and he rejected *A. arenosa* as a species

When writing the Sonoran treatment of *Sarcogyne*, Knudsen & Standley (2008) only examined specimens of *S. arenosa* from California. There the species is frequent on consolidated soil, sandstone, and decaying granite (often occurring with *S. similis* H. Magn.) and on calcareous rock (there often occurring with *S. regularis*). We report *S. arenosa* as new to Colorado, Kansas, and Texas.

Sarcogyne arenosa is a member of the *Acarospora glaucocarpa*–*Sarcogyne regularis* group, which will eventually be segregated as a new genus.

SPECIMENS EXAMINED. – U.S.A. Colorado. LARIMER CO.: Owl Canyon, 9.7 miles N of Teds Place (junction of Hwy. 287 & 14), 1830 m, on limestone outcrops of Ingleside formation in *Pinus edulis* stand, 6.vi.1955, *S. Shushan & W.A. Weber* S4742 (UPS). Kansas. DOUGLAS CO.: Clinton Lake Wildlife Area above Coblenz Marsh, 38°54'12"N 95°29'43"W, 277 m, on limestone, 21.iii.2007, *C.A. Morse* 14578 & *N. Kuhn* (KANU, UCR). Texas. EL PASO CO.: Franklin Mountains, 31°48'15"N 106°29'W, 1646 m, on calcareous rock, 14.viii.2006, *R.D. Worthington* 34204 (UCR, UTEP).

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Literature cited

- Esslinger TL. 2008. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University: <http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm> (first posted 1 December 1997, most recent version (#14) 8 October 2008), Fargo, North Dakota. Accessed May 9, 2009.
- Halıcı MG, Kocakaya M, Aksoy A. 2009. *Lichenostigma anatolicum* sp. nov. (Ascomycota, Lichenotheliaceae) on a brown *Acarospora* from central Turkey. *Mycotaxon* 108: 67–72.
- Harris RC, Ladd D. 2005. Preliminary draft: Ozark Lichens, Enumerating the lichens of the Ozark Highlands of Arkansas, Illinois, Kansas, Missouri, and Oklahoma. Published by the authors, Bronx, NY. 267 pp.
- Hansen CJ, Lendemer JC, Beeching SQ. 2008. Contributions to the lichen flora of Alabama: recent collections from four counties. *Opuscula Philolichenum* 5: 43–48.
- Knudsen K, Kocourková J. 2008. Noteworthy records. New records of lichen and lichenicolous fungi from California. *Crossosoma* 34(1): 37–39.
- Knudsen K, Standley SM. 2008b ("2007") *Sarcogyne*. In: TH Nash III, C Gries, F Bungartz (eds.): Lichen Flora of the Greater Sonoran Region, Vol. 3. Lichens Unlimited, Arizona State University, Tempe, Arizona, pp. 289–296.

- Kocourková J, Knudsen K. 2008. Four new Lichenicolous Fungi from North America. *Evansia* 25(2): 62–64.
- Lendemer JC, Tripp EA. 2008. Contributions to the Lichen Flora of North Carolina: A preliminary checklist of the lichens of Gorges State Park. *The Bryologist* 111(1): 4–67.
- Magnusson AH. 1929. A monograph of the genus *Acarospora*. Kongl. Svenska Vetenskaps Akademiens Handlingar ser. 3, 7: 1–400.
- Magnusson AH. 1935. On the species of *Biatorella* and *Sarcogyne* in America. *Annales de Cryptogamie Exotique* 7: 115–145.
- Mycobank. 2009. www.mycobank.org. accessed at 9 May 2009.
- Nylander W. 1863. Lichenes. In: J Triana, JE Planchon. *Prodromus Florae Novo-Granatensis ou Énumération des plantes de la Nouvelle-Grenade avec description des espèces nouvelles*. *Annal. Sci. Nat. Bot.* ser. 4, 19: 286–382.
- Perlmutter GB, Lendemer JC. 2008. Contributions to the Lichen Biota of North Carolina: a preliminary checklist of the lichens and allied fungi of William B. Umstead State Park. *Opuscula Philolichenum* 5: 67–76.
- Willey H. 1890. A synopsis of the genus *Arthonia*. New Bedford. 62 pp.
- Zahlbruckner A. 1922. *Catalogus Lichenum Universalis*. Borntraeger, Leipzig. pp. 321–696.

Validation of *Malasseziaceae* and *Ceraceosoraceae* (*Exobasidiomycetes*)

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Abstract — Names of two families in the *Exobasidiomycetes*, *Malasseziaceae* and *Ceraceosoraceae*, are validated.

Key words — *Ceraceosorales*, *Malasseziales*, taxonomy, ustilaginomycetous fungi

Introduction

Of the eight orders in the class *Exobasidiomycetes* Begerow et al. (Begerow et al. 2007, Vánky 2008a), four include smut fungi (see Vánky 2008a, b for the current meaning of ‘smut fungi’) while the rest include non-smut fungi (i.e., *Ceraceosorales* Begerow et al., *Exobasidiales* Henn., *Malasseziales* R.T. Moore emend. Begerow et al., *Microstromatales* R. Bauer & Oberw.). For two orders, *Ceraceosorales* and *Malasseziales*, families have not been previously formally described. We validate the names for the two missing families below.

Validation of two family names

Malasseziaceae Denchev & R.T. Moore, fam. nov.

MYCOBANK MB 515089

Fungi Exobasidiomycetum zoophili gemmationi monopolari proliferationi gemmarum percurrenti vel sympodiali, cellulis lipodependentibus vel lipophilis. Paries cellulae multistratosus. Membrana plasmatica evaginationi helicoideae. Teleomorphus ignotus.

GENUS TYPICUS: *Malassezia* Baill., *Traité de botanique médicale cryptogamique*: 234 (1889).

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Zoophilic members of the *Exobasidiomycetes* with a monopolar budding yeast phase showing percurrent or sympodial proliferation of the buds. Yeasts lipid-dependent or lipophilic (excluding the case of *Malassezia pachydermatis*), with a multilayered cell wall and a helicoidal evagination of the plasma membrane. Teleomorph unknown.

The preceding description is based on the characteristics shown in Begerow et al. (2000: 59, as a description of *Malasseziales* R.T. Moore, emend. Begerow et al.). *Malasseziaceae* is a monotypic family. The current placement of the *Malasseziaceae* in the system of the ustilaginomycetous fungi and associated yeasts is based on results obtained from molecular phylogenetic analyses (Begerow et al. 2000, 2007, Fell et al. 2000, Sugita et al. 2002, Sampaio 2004, Weiss et al. 2004, Kumar et al. 2007; see also Hibbet et al. 2007, who did not place the *Malasseziales* in any class but just treated them as ‘*Ustilaginomycotina incertae sedis*’).

The genus *Malassezia* comprises lipid-dependent or lipophilic yeasts (excluding *M. pachydermatis*, which does not need lipid for its growth — Midgley 2000, Gandra et al. 2008, Prado et al. 2008). It includes thirteen species found on the host's skin and in the auricular canals of humans and wild and domestic animals (mainly dogs and cats): *M. caprae* J. Cabañes & Boekhout 2007, *M. dermatis* Sugita et al. 2002, *M. equina* J. Cabañes & Boekhout 2007, *M. furfur* (C.P. Robin) Baill. 1889, *M. globosa* Midgley et al. 1996, *M. japonica* Sugita et al. 2003, *M. nana* Hirai et al. 2004, *M. obtusa* Midgley et al. 1996, *M. pachydermatis* (Weidman) C.W. Dodge 1935, *M. restricta* E. Guého et al. 1996, *M. slooffiae* J. Guillot et al. 1996, *M. sympodialis* R.B. Simmons & E. Guého 1990, and *M. yamatoensis* Sugita et al. 2004 (Marcon & Powell 1992, Guého et al. 1996, Midgley 2000, Sugita et al. 2002, 2003, 2004, Hirai et al. 2004, Coutinho et al. 2006, Morishita & Sei 2006, Cabañes et al. 2007, Gandra et al. 2008, Prado et al. 2008).

***Ceraceosoraceae* Denchev & R.T. Moore, fam. nov.**

MYCOBANK # MB 515091

Fungi Exobasidiomycetum hyphis intracellularibus.

GENUS TYPICUS: *Ceraceosorus* B.K. Bakshi, in Cunningham et al., *Mycologia* 68: 649 (1976).

Members of the *Exobasidiomycetes* having intracellular hyphae — characters given by Begerow et al. (2007: 908) for the *Ceraceosorales* Begerow et al.

Ceraceosoraceae is a monotypic family with a monotypic genus. *Ceraceosorus bombacis* (B.K. Bakshi) B.K. Bakshi 1976 causes a disease of an economically important lumber-producing tree, *Bombax ceiba* L. (*Bombacaceae*), in India (Cunningham et al. 1976).

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Literature cited

- Begerow D, Bauer R, Boekhout T. 2000. Phylogenetic placements of ustilaginomycetous anamorphs as deduced from nuclear LSU rDNA sequences. *Mycological Research* 104: 53–60.
- Begerow D, Stoll M, Bauer R. 2007. A phylogenetic hypothesis of *Ustilaginomycotina* based on multiple gene analyses and morphological data. *Mycologia* 98[2006]: 906–916.
- Cabañes FJ, Theelen B, Castellá G, Boekhout T. 2007. Two new lipid-dependent *Malassezia* species from domestic animals. *FEMS Yeast Research* 7: 1064–1076.
- Coutinho SD, Fedullo JD, Corrêa SH. 2006. Isolation of *Malassezia* spp. from cerumen of wild felids. *Medical Mycology* 44: 383–387.
- Cunningham JL, Bakshi BK, Lentz PL, Gilliam MS. 1976. Two new genera of leaf-parasitic fungi (*Basidiomycetidae: Brachybasidiaceae*). *Mycologia* 68: 640–654.
- Fell JW, Boekhout T, Fonseca A, Scorzetti G, Statzell-Tallman A. 2000. Biodiversity and systematics of basidiomycetous yeasts as determined by large-subunit rDNA D1/D2 domain sequence analysis. *International Journal of Systematic and Evolutionary Microbiology* 50: 1351–1371.
- Gandra RF, Gambale W, Simão RCG, Ruiz LS, Durigon EL, Camargo LMA, Giudice MC, Sanfilippo LF, Araújo J, Paula CR. 2008. *Malassezia* spp. in acoustic meatus of bats (*Molossus molossus*) of the Amazon Region, Brazil. *Mycopathologia* 165: 21–26.
- Guého E, Midgley G, Guillot J. 1996. The genus *Malassezia* with description of four new species. *Antonie van Leeuwenhoek* 69: 337–355.
- Hibbett DS, Binder M, Bischoff JF, Blackwell M, Cannon PF, Eriksson OE, Huhndorf S, James T, Kirk PM, Lücking R, Thorsten Lumbsch H, Lutzoni F, Matheny PB, McLaughlin DJ, Powell MJ, Redhead S, Schoch CL, Spatafora JW, Stalpers JA, Vilgalys R, Aime MC, Aptroot A, Bauer R, Begerow D, Benny GL, Castlebury LA, Crous PW, Dai Y-C, Gams W, Geiser DM, Griffith GW, Gueidan C, Hawksworth DL, Hestmark G, Hosaka K, Humber RA, Hyde KD, Ironside JE, Kõljalg U, Kurtzman CP, Larsson K-H, Lichtwardt R, Longcore J, Miądlikowska J, Miller A, Moncalvo J-M, Mozley-Standridge S, Oberwinkler F, Parmasto E, Reeb V, Rogers JD, Roux C, Ryvarden L, Sampaio JP, Schüssler A, Sugiyama J, Thorn RG, Tibell L, Untereiner WA, Walker C, Wang Z, Weir A, Weiss M, White MM, Winka K, Yao Y-J, Zhang N 2007. A higher-level phylogenetic classification of the *Fungi*. *Mycological Research* 111: 509–547.
- Hirai A, Kano R, Makimura K, Duarte ER, Hamdan JS, Lachance M-A, Yamaguchi H, Hasegawa A. 2004. *Malassezia nana* sp. nov., a novel lipid-dependent yeast species isolated from animals. *International Journal of Systematic and Evolutionary Microbiology* 54: 623–627.
- Kumar TKA, Celio GJ, Matheny PB, McLaughlin DJ, Hibbett DS, Manimohan P. 2007. Phylogenetic relationships of *Auriculosocypha* based on ultrastructural and molecular studies. *Mycological Research* 111: 268–274.
- Marcon MJ, Powell DA. 1992. Human infections due to *Malassezia* spp. *Clinical Microbiology Reviews* 5(2): 101–119.

- Midgley G. 2000. The lipophilic yeasts: state of the art and prospects. *Medical Mycology* 38 (Suppl. 1): 9–16.
- Moore RT. 1980. Taxonomic proposals for the classification of marine yeasts and other yeast-like fungi including the smuts. *Botanica Marina* 23: 361–373.
- Morishita N, Sei Y. 2006. Microreview of Pityriasis versicolor and *Malassezia* species. *Mycopathologia* 162: 373–376.
- Prado MR, Brito ÉHS, Brilhante RSN, Cordeiro RA, Leite JJG, Sidrim JJC, Rocha MFG. 2008. Subculture on potato dextrose agar as a complement to the broth microdilution assay for *Malassezia pachydermatis*. *Journal of Microbiological Methods* 75: 341–343.
- Sampaio JP. 2004. Diversity, phylogeny and classification of basidiomycetous yeasts. 49–80, in R. Agerer, M. Piepenbring, P. Blanz (eds), *Frontiers in basidiomycote mycology*. IHW-Verlag, Eching, Germany.
- Sugita T, Takashima M, Shinoda T, Suto H, Unno T, Tsuboi R, Ogawa H, Nishikawa A. 2002. New yeast species, *Malassezia dermatis*, isolated from patients with atopic dermatitis. *Journal of Clinical Microbiology* 40: 1363–1367.
- Sugita T, Takashima M, Kodama M, Tsuboi R, Nishikawa A. 2003. Description of a new yeasts species, *Malassezia japonica*, and its detection in patients with atopic dermatitis and healthy subjects. *Journal of Clinical Microbiology* 41: 4695–4699.
- Sugita T, Tajima M, Takashima M, Amaya M, Saito M, Tsuboi R, Nishikawa A. 2004. A new yeast, *Malassezia yamatoensis*, isolated from a patient with seborrheic dermatitis, and its distribution in patients and healthy subjects. *Microbiology and Immunology* 48: 579–583.
- Vánky K. 2008a. Smut fungi (*Basidiomycota* p.p., *Ascomycota* p.p.) of the world. Novelties, selected examples, trends. *Acta Microbiologica et Immunologica Hungarica* 55: 91–109.
- Vánky K. 2008b. *Restilago capensis* gen. et sp. nov., an ascomycetous smut fungus. *Mycologia Balcanica* 5: 69–72.
- Weiss M, Bauer R, Begerow D. 2004. Spotlights on heterobasidiomycetes. 7–48, in R. Agerer, M. Piepenbring, P. Blanz (eds), *Frontiers in basidiomycote mycology*. IHW-Verlag, Eching, Germany.

New records of smut fungi. 1. *Thecaphora hedysari*

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Abstract — *Thecaphora hedysari* is reported for the first time from Kyrgyzstan on a new host plant, *Hedysarum kirghisorum*. It represents the second known locality of *Thecaphora hedysari*.

Key words — taxonomy, *Ustilaginomycetes*

Introduction

In this series, novel findings of smut fungi will be recorded.

In this article, *Thecaphora hedysari* is reported as a new species for Kyrgyzstan, found on a new host plant, *Hedysarum kirghisorum*. It is the second known global location of this smut fungus.

Material and methods

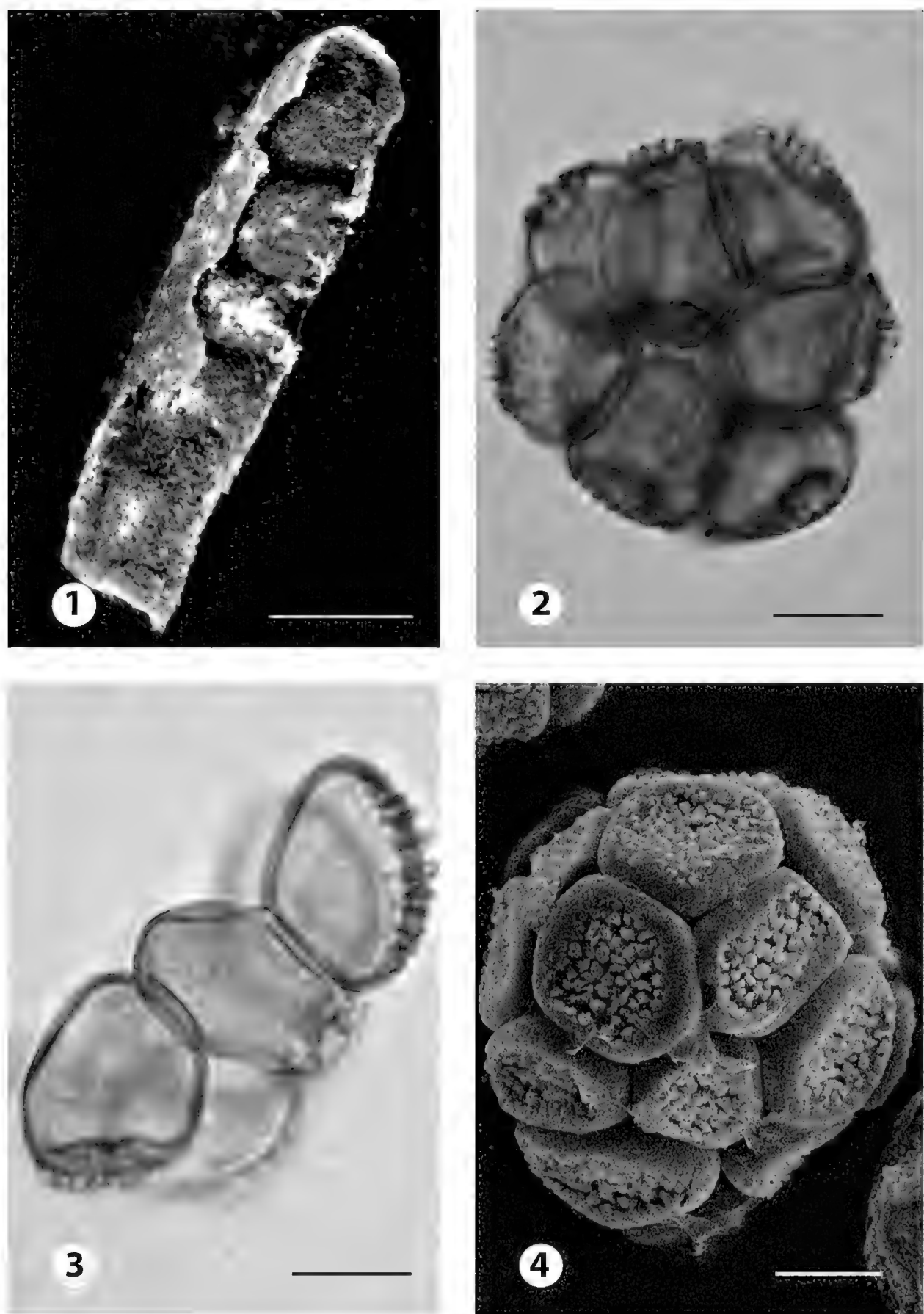
Material from the herbarium of Komarov Botanical Institute, Russian Academy of Sciences, St Petersburg (LE) was examined under light microscope (LM) and scanning electron microscope (SEM). For LM observations, the spores were mounted in lactophenol solution on glass slides, gently heated to boiling point and then cooled. For SEM, the spores were attached to specimen holders by double-sided adhesive tape and coated with gold with an ion sputter. The surface structure of spores was observed at 10 kV and photographed with a JEOL SM-6390 scanning electron microscope.

A new record

Thecaphora hedysari Vánky, Trans. Mycol. Soc. Japan 32: 153, 1991. FIGS 1–4

SORI in the fruits, destroying the seeds and replacing them with a spore mass. Infected fruits swollen. In the studied specimen, all collected fruits are

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FIGS 1–4. *Thecaphora hedysari* on *Hedysarum kirghisorum* (LE 261 758). 1. Part of a legumen with destroyed seeds. 2–3. Spores in LM. 4. Spore ball in SEM. Scale bars: 1 = 1 cm, 2–4 = 10 μ m.

infected; infection probably systemic. SPORE MASS granular, dark reddish brown (bay, based on the Colour identification chart of Anonymous 1969), composed of spore balls. SPORE BALLS globose, subglobose, ovoid, broadly ellipsoidal to ellipsoidal, $35\text{--}79 \times 31\text{--}62 \mu\text{m}$, yellowish brown, composed of 10–40 (? more) spores, easily separating into single spores or small groups of spores. SPORES in surface view irregularly and rounded polygonal, suborbicular or broadly elliptical in outline, $16.5\text{--}23 \times 14.5\text{--}18 \mu\text{m}$; in lateral view more or less cuneate (usually, rounded or truncate-cuneate at the base), broadly elliptical, suborbicular or irregularly and rounded elongated in outline, $12.5\text{--}26 \mu\text{m}$ long (including the ornaments), $12.5\text{--}24.5 \mu\text{m}$ width; yellowish brown; wall smooth on the contact surfaces, $0.8\text{--}1.2 \mu\text{m}$ thick, coarsely verrucose on the free surface; warts densely situated, up to $1.6\text{--}2 \mu\text{m}$ high.

SPECIMENS EXAMINED — On *Hedysarum kirghisorum* B. Fedtsch.: KYRGYZSTAN, the Issyk-Kul hollow, W of Karakul Lake, 11 June 1965, leg. N.A. Gorbunova (LE 261 758, SOMF 27 697).

DISTRIBUTION. On *Fabaceae*: *Hedysarum*, Central Asia.

COMMENTS — *Thecaphora hedysari* has been previously reported only from the type locality (Mongolia, the Mongolian Altai Mts), on *Hedysarum ferganense* Korsh. (Vánky 1991). That smut fungus is a rare species and deserves an IUCN threatened status, globally assessed here as Data Deficient. *Hedysarum kirghisorum* is distributed in Kyrgyzstan, Kazakhstan, and China. The type host plant also has a Central Asian distribution.

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We gratefully acknowledge Dr Kálmán Vánky (Herbarium *Ustilaginales* Vánky, Tübingen, Germany) and Dr Roger G. Shivas (Queensland Primary Industries and Fisheries, Australia) for critically reading the manuscript and serving as pre-submission reviewers. The financial support from the Bulgarian National Science Fund (grant no. DO 02-181/2008) is gratefully acknowledged.

Literature cited

- Anonymous. 1969. Flora of British fungi. Colour identification chart. Her Majesty's Stationery Office, Edinburgh.
- Vánky K. 1991. *Thecaphora* (*Ustilaginales*) on *Leguminosae*. Transactions of the Mycological Society of Japan 32: 145–159.

The family *Hymenochaetaceae* from México 4. New records from Sierra de Álamos–Río Cuchujaqui biosphere reserve

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Abstract — *Fomitiporella melleopora*, *Fuscoporia rhabarbarina*, *Hymenochaete americana*, *Inonotus patouillardii*, and *Inonotus tropicalis* are described and illustrated as new records from México. The specimens were collected in tropical deciduous forest in the Sierra de Álamos–Río Cuchujaqui Biosphere Reserve, Sonora, México.

Key words — *Basidiomycota*, *Hymenochaetales*, taxonomy

Introduction

The *Hymenochaetaceae* was described by Donk (1948) to include fungi with annual to perennial, resupinate to stipitate, clavarioid or coralloid basidiomata with a smooth, rugose, irpiciform, hydroid or poroid hymenophore, and developing a xanthochroic reaction in KOH. Their hyphal system is either monomitic or dimitic with generative hyphae that are always simple-septate. In addition, setoid elements (setae, hyphal setae, setal hyphae) are variably present in the hymenium, trama, or context or on the pileus surface. Most species are lignicolous and cause a white rot of dead or living wood, although some species are reported as mycorrhizal and growing in soil.

Phylogenetic analysis of sequence data of rDNA (nSSU, mtSSU and nLSU) has demonstrated that several aphyllorphoroid and agaricoid fungi previously classified in various families (*Agaricaceae*, *Polyporaceae*, *Corticaceae*, *Stereaceae* and *Hymenochaetaceae*) belong to or are closely related to the *Hymenochaetales* (Wagner & Fischer 2002, Larsson et al. 2006).

Our study expanded the knowledge about *Hymenochaetaceae* diversity in the Sierra de Álamos–Río Cuchujaqui biosphere reserve. We discuss below five species that are new to the Mexican mycobiota.

Materials and methods

The examined specimens were collected in the Sierra de Álamos–Río Cuchujaqui biosphere reserve, Sonora, México, in September 2006. Voucher specimens are deposited in ENCB Herbarium with duplicate in CESUES. Herbarium ENCB is abbreviated according to Holmgren & Holmgren (1998). Morphological examinations followed Ryvarden (1991) and Cifuentes et al. (1986). Keys in parentheses after colors in basidiomata descriptions are following the Methuen Handbook of Colour (Kornerup & Wanscher 1978). Measurements of anatomical characters were taken from rehydrated tissues in 5% aqueous KOH and inamyloid reactions were taken with Melzer's reagent. Longitudes and latitudes were obtained with GPS etrex (Garmin). The drawing lines were made to scale and was utilized an optical microscopy with clear camera. The macroscopic pictures were taken with a Nikon Coolpix 4300.

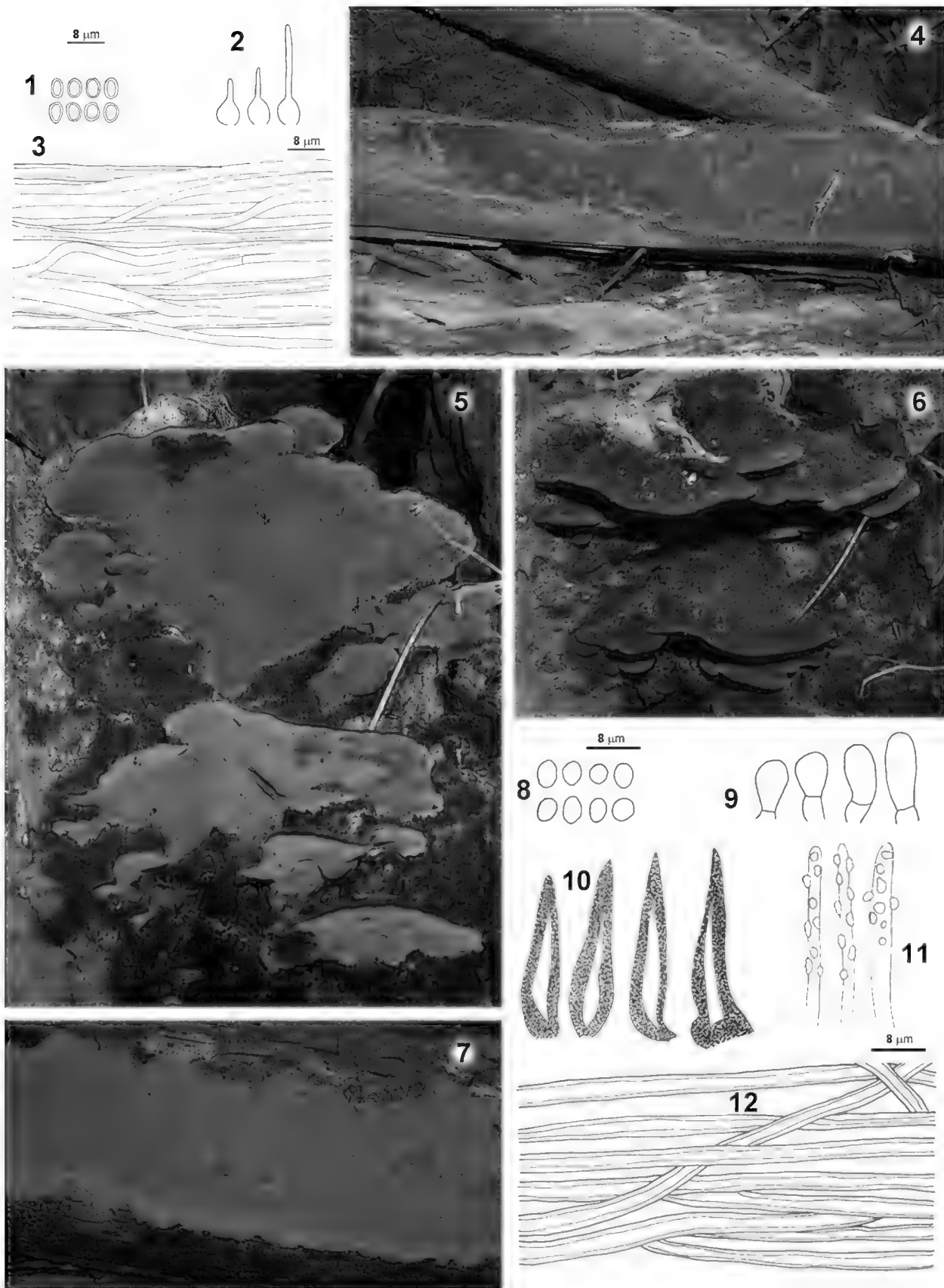
Taxonomy

Fomitiporella melleopora Murrill, N. Amer. Fl. 9(1): 13, 1907.

FIGS. 1–4

Basidiome perennial, resupinate, becoming widely effused, reaching 150–250 × 25–45 × 2–5 mm, adnate, corky. Margin sterile, up to 1 mm wide, brownish yellow (5C7), golden brown (5D7) to light brown (6D8), dark brown (6F5) to black with age, matted, fimbriate. Hymenophore poroid, cracked with age, pores circular to angular, 4–6(–7) per mm, iridescent, golden brown (5D7), yellowish brown (5E7), cocoa brown (6E6), umber (6F6) to dark brown (6F7), light brown (6D5) when moved, edges thin and entire; tubes up to 4 mm deep, indistinctly stratified, tough to woody, yellowish brown (5E7), cocoa brown (6E6) to reddish brown (8E8). Context up to 1 mm thick, yellowish brown (5E8) to reddish brown (8E8), fibrous, tough, azonate, in some parts with a thin, black crust next to the substratum and it is continuous to the margin.

HYPHAL SYSTEM dimitic, generative hyphae simple septate, hyaline to pale yellow in KOH, simple to slightly branched, thin- to thick-walled, 2.4–4 µm diam; skeletal hyphae yellowish brown to reddish brown, unbranched or rare branched, thick-walled, 3.2–6.4 µm diam. HYMENOPHORAL TRAMA with parallel to subparallel hyphae, generative hyphae hyaline to pale yellow in KOH, thin- to thick-walled, non- to shortly branched, 2.4–4 µm wide; skeletal hyphae yellowish brown to reddish brown in KOH, unbranched, thick-walled, 3.2–5 µm diam. CONTEXTUAL TRAMA with slightly interwoven hyphae, generative hyphae hyaline to pale yellow in KOH, simple to scarcely branched, thick-



FIGS. 1–4. *Fomitiporella melleopora*: 1. Basidiospores. 2. Cystidioles. 3. Hyphae of hymenophoral trama. 4. Resupinate basidiome. FIGS. 5–12. *Fuscoporia rhabarbarina*: 5. Basidiospores. 6. Basidioles. 7. Hymenial setae. 8. Generative hyphae with incrustated crystals. 9. Hyphae of hymenophoral trama. 10. Hymenophore. 11. Pileate basidiome. 12. Resupinate basidiome.

walled, 2.4–4 μm wide; skeletal hyphae yellowish brown to reddish brown in KOH, unbranched, thick-walled, 3.2–6.4 μm diam. SETAE absent in all parts. CYSTIDIOLES 12–20 \times 5.6–7.2 μm , hyaline in KOH, sublageniform to ventricose-rostrate. BASIDIA 10–14 \times 5.6–7.2 μm , clavate, tetraspored, hyaline in KOH. BASIDIOSPORES 4–4.8 \times 2.8–3.2 μm , ellipsoid to ovoid, somewhat flattened on one side, pale yellow, golden yellow to pale brown in KOH, inamyloid, thin-walled to slightly thick-walled, smooth.

ECOLOGY, RANGE AND DISTRIBUTION — The Mexican specimens were collected during September on dead *Cordia* wood of in caducifolious tropical forests. This species has been reported by Lowe (1966 as *Poria melleopora* (Murrill) Sacc. & Trotter) from Louisiana, U.S.A. and Venezuela and by Gilbertson & Ryvardeen (1987) and Larsen & Cobb-Pouille (1990, as *Phellinus melleoporus* (Murrill) Ryvardeen) from Louisiana to Florida and South America. This is the first record to Mexico in Sonora State.

REPRESENTATIVE SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Álamos, RANCHO LAS UVALAMAS, 12.IX.1994, M. Esqueda & E. Pérez-Silva (CESUES 1814); MESA DEL TRIGO (108°41'21.2"W 26°58'12.4"N) elev. 592.2 m, 14.IX.2006, R. Valenzuela 13128 (ENCB).

COMMENTS — *Fomitiporia melleopora* is characterized by medium sized pores, lack of hymenial setae, and basidiospore color, size and shape. Other species with resupinate basidiomes are *F. umbrinella*, *F. cavicola*, and *F. inermis*. The first is separated from *F. melleopora* by smaller pores (7–10 per mm) and dark brown spores, the second has a similar pore size but darker and wider spores (4–5 \times 3.5–4.5 μm) and grows on *Quercus* in Europe, and the third species has slightly larger pores (4–5 per mm) and and slightly larger (4–6 \times 3–5 μm) reddish brown spores. *Fomitiporia caryophylli* is separated easily from *F. melleopora* by pileate basidiomata, smaller (7–10 per mm) pores, slightly smaller (3–4 \times 2.5–3 μm) spores (Murrill 1907, Bondartseva & Herrera 1980, Wagner & Fischer 2002).

Fuscoporia rhabarbarina (Berk.) Groposo, Log.-Leite & Góes-Neto, Mycotaxon 101: 61, 2007.

FIGS. 5–12

Basidiome perennial, 10–180 \times 24–62 mm, resupinate, effuse-reflexed to pileate-sessile, the pilei dimidiate to semicircular, coriaceous in thin specimens and corky in thicker specimens. Pileus 18–40 \times 6–20 \times 2–10 mm, plane to conchate, the surface brown (6E8), reddish brown (8E8, 8F8) to dark brown (6F7, 6F4), black with age, in section with a thin black crust, finely velutinate when young, glabrous with age, concentrically sulcate in narrow bands. Margin fertile to sterile, obtuse, light brown (6D8) to cinnamon brown (6D6). Hymenophore poroid, pores circular, entire, 6–9 per mm, cinnamon brown (6D6), brown (6E6), to reddish brown (8E8), tubes stratified, up to 5 mm deep,

concolorous with the pores. Context up to 2 mm thick, yellowish brown (5E8), with a black line developing into a cuticle from the base in pileate specimens.

HYPHAL SYSTEM dimitic, generative hyphae simple septate, hyaline, inamyloid, 2–4 μm diam, simple to branched; skeletal hyphae nonseptate, yellowish brown to reddish brown, unbranched, thick-walled, 3–5 μm diam. **HYMENOPHORAL TRAMA** dominated by skeletal hyphae, slightly interwoven to subparallel; generative hyphae infrequent, hyaline, thin-walled, simple to branched, 2–3.2 μm diam; skeletal hyphae dominant, yellowish brown to reddish brown in KOH, unbranched, 3–5 μm diam, thick-walled. **CONTEXTUAL TRAMA** dominated by skeletal hyphae, subparallel; generative hyphae infrequent, hyaline, thin-walled, simple to branched, 2–4 μm diam; skeletal hyphae dominant, yellowish brown to reddish brown in KOH, thick-walled, unbranched, 3–5 μm diam. **DISSEPIMENT** edge with generative hyphae with incrustated crystals. **HYMENIAL SETAE** 20–30 \times 4.8–7.2 μm , mostly originating from tramal hyphae and projecting in the hymenial layer up to 16 μm , subulate, reddish brown to dark brown in KOH, thick-walled (up to 1.6 μm thick). Basidia not observed, basidioles subglobose to broadly clavate, 8–12 \times 5.6–10 μm , hyaline in KOH, with simple septum at the base. Basidiospores 3.2–4 \times 2–3 μm , ellipsoid, hyaline in KOH, inamyloid, thin-walled, smooth.

ECOLOGY, RANGE AND DISTRIBUTION — The Mexican specimens were collected in September on dead wood or living trees of *Leguminosae* in a caducifolious tropical forest. This species has been reported from Cuba, Mexico, and Costa Rica by Ryvarden (2004, as *Phellinus rhabarbarinus* (Berk.) G. Cunn.: see COMMENTS), Argentina (as *Fomes rheicolor* Lloyd), New Guinea and Fiji (as *Phellinus rhabarbarinus*) by Ryvarden & Johansen (1980), Brazil by Groposo et al. (2007), and East China by Dai (1999).

REPRESENTATIVE SPECIMENS EXAMINED — **MEXICO. SONORA:** Municipality of Álamos, PROMONOTORIOS (109°02'10.5"W 27°00'54.1"N) elev. 600 m, 12.IX.2006, R. Valenzuela 13041 (ENCB); PALO INJERTO (108°43'57.9"W 27°02'50.9"N) elev 425 m, 13.IX.2006, R. Valenzuela 13072 (ENCB); MESA DEL TRIGO (108°41'21.2"W 26°58'12.4"N) elev. 590 m, 14.IX.2006, R. Valenzuela 13129 (ENCB); EL SABINITO (108°48'14.2"W 27°00'5.5"N) elev. 377 m, 16.IX.2006, R. Valenzuela 13162 (ENCB), 13165 (ENCB), 13072 (ENCB).

COMMENTS — *Fuscoporia rhabarbarina* is characterized by a glabrous pileus surface with sulcate zones and a distinctive black crust, yellowish brown context, small pores, and the size and shape of the inamyloid hyaline basidiospores. It is closely related to *F. gilva* (Schwein.) T. Wagner & M. Fisch., *F. callimorpha* (Lév.) Groposo et al., and *Phellinus roseocinereus* (Murrill) D.A. Reid, all of which differ in lacking a black crust on the pileus. Ryvarden & Johansen (1980) and Corner (1991) considered *P. roseocinereus* to be a synonym of *P. callimorphus* (Lév.) Ryvarden; later, Ryvarden (2004) considered both names to be synonyms of *P. rhabarbarinus* (based on Mexican and Cuban specimens identified as *P. roseocinereus*). Loguercio-Leite & Wright (1995) studied

P. roseocinereus specimens from Guadaloupe and México and evidenced great similarity with Jamaican and Brazilian specimens of *P. callimorphus*. Mexican specimens of ENCB herbarium identified as *F. callimorpha* and *P. roseocinereus* are very different from the Sonoran specimens of *F. rhabarbarina*. Larsen & Cobb-Pouille (1990) considered these species as autonomous. Resupinate, effuse-reflexed and pileate-sessile basidiomata were present in all Mexican specimens examined, probably due to climatic conditions.

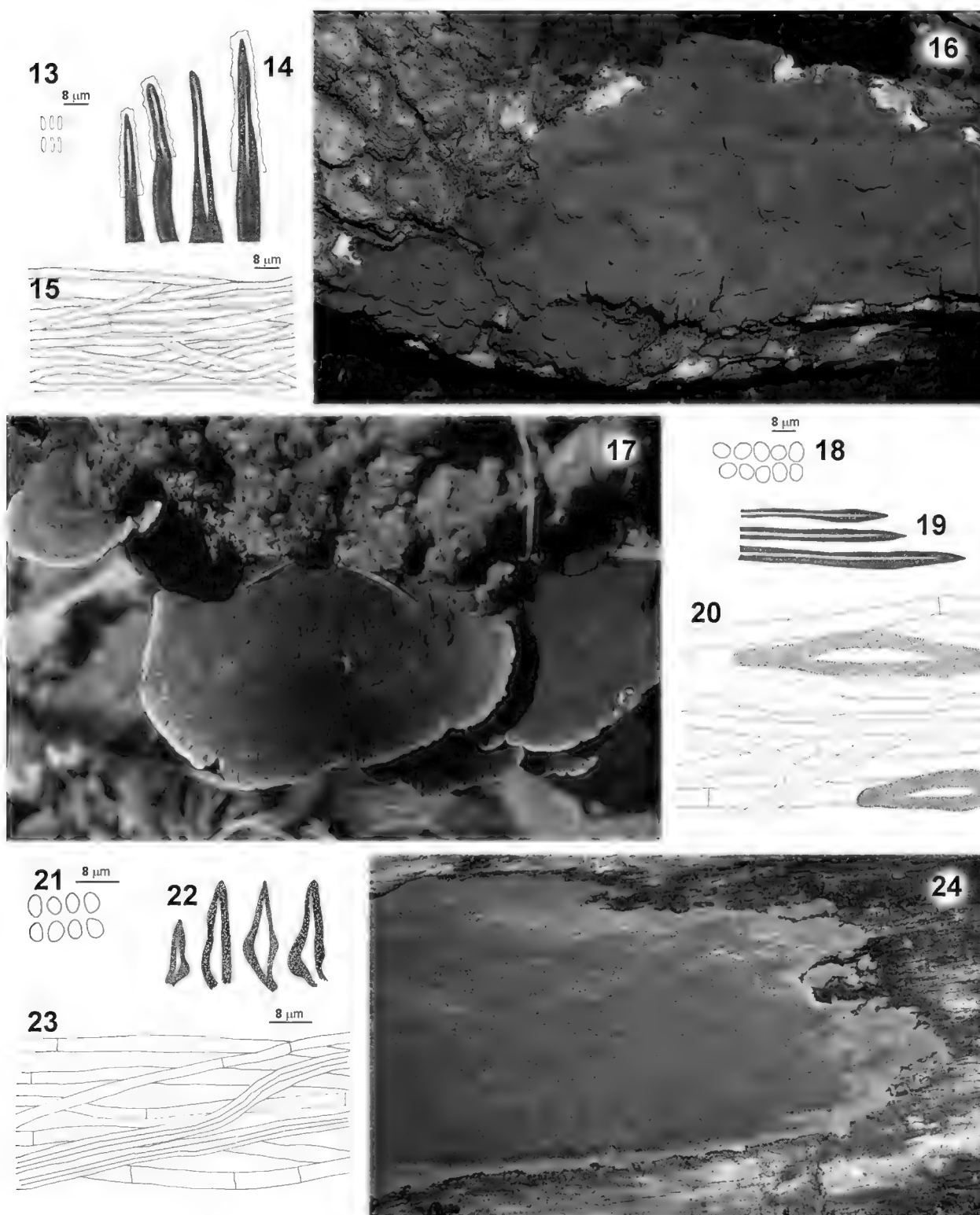
Hymenochaete americana Gresl. & Parmasto, Folia Criptog. Estonica 37: 59, 2001.

FIGS. 13–16

Basidiome annual, 26–30 mm diam, very thin (less than 1 mm thick), resupinate, crustose, then confluent, papiraceus, separable, fragile, brittle in dry specimens. Hymenophore smooth, with scattered rounded tubercles, slightly cracked, cocoa brown (6E6) to chocolate brown (6F4), grayish brown (6E3) to the margin. Margin sterile, up to 1 mm broad, golden brown (5D7) to light brown (6D8). Context very thin, composed of a thin layer of hyphae and stratose setal layer, overhead of context, there is a thin dark layer called cortex and over this layer there is a tomentum.

HYPHAL SYSTEM pseudodimitic, generative hyphae yellowish to yellowish brown in KOH, simple septate, with thick-walled, 2–3.5 µm diam; skeletal hyphae brown to reddish brown, without or simple septate very distant, thick-walled, 3–4.5 µm diam. CORTEX 16–56 µm thick, hyphae subparallel, densely agglutinated, brown to dark brown in KOH, hard to characterize. TOMENTUM 50–80 µm thick, hyphae loosely interwoven, yellowish brown in KOH, with simple septate, thick-walled, 4–5 µm diam. CONTEXTUAL HYPHAL LAYER thin, hyphae more or less loosely interwoven to subparallel arranged, generative hyphae yellowish to yellowish brown, 2–3.4 µm diam; skeletal hyphae brown to reddish brown in KOH, 3–5 µm diam. SETAL LAYER 50–350 µm thick, non distinguish from the contextual layer, 1–3 stratus; setae numerous, 80–120 × 8–12 µm, projecting 50–70 µm of the hymenium, subulate to fusiform, with acute tip, straight, naked or incrustated with small groups of polyhedric crystals, sometimes crystals forming a narrowly conical cap. Cystidia and hyphidia absent. BASIDIA 18–22.4 × 5.6–6.4 µm, tetra-spored, clavate to cylindrical, hyaline to yellowish in KOH, sterigmata 3–4 µm long. BASIDIOSPORES 8–9.6 × 2.4–3.2 µm, cylindrical, slightly curved, hyaline in KOH, inamyloid, smooth, thin-walled.

ECOLOGY, RANGE AND DISTRIBUTION — The Mexican specimen was collected during September on dead oak in a *Quercus* forest. This species has been reported from South America (Tierra del Fuego, Argentina, and Río Grande do Sul, Brazil) and North America (Arizona, U.S.A.) (Parmasto 2000, 2001). This is the first record to Mexico in Sonora State.



FIGS. 13–16. *Hymenochaete americana*: 13. Basidiospores. 14. Hyphal setae. 15. Hyphae of the subiculum. 16. Basidiome. FIGS. 17–20. *Inonotus patouillardii*: 17. Basidiome. 18. Basidiospores. 19. Hyphal setae. 20. Hyphae of hymenophoral trama with hyphal setae. FIGS 21–24. *Phellinus tropicalis*: 21. Basidiospores. 22. Hyphal setae. 23. Hyphae of hymenophoral trama. 24. Basidiome.

REPRESENTATIVE SPECIMEN EXAMINED — MEXICO. SONORA: Municipality of Álamos, LA CAÑITA (108°38'59.52"W 26°59'32.6"N) elev. 657 m, 15.IX.2006, R. Valenzuela 13074 (ENCB).

COMMENTS — This species is characterized by thin, resupinate basidiome, incrusted setae with crystals forming a narrowly conic cap, and cylindrical, slightly curved basidiospores. *H. allantospora* Parmasto, a similar species with effuse-reflexed basidiomata and incrusted setae, is distinguished by rare and larger setae that lack narrowly conic crystal caps and larger curved to allantoid spores.

Pseudochaete tabacina (Sowerby) T. Wagner & M. Fisch., which is also morphologically similar, grows on *Quercus*, and has resupinate to effuse-reflexed basidiomata, is differentiated by smaller spores and mostly naked setae or slightly incrusted with granules or small crystals. Parmasto (2000, 2001) noted that *Hymenochaete vaginata* G. Cunn. appears to be closely related to *H. americana*, but the first differs in sometimes possessing effused-reflexed basidiomata, presence of numerous hyaline, yellow or pale brown hyphidia, larger setae $90\text{--}160 \times 9\text{--}14\ \mu\text{m}$ encrusted or not with small crystals, and somewhat smaller basidiospores.

Inonotus patouillardii (Rick) Imazeki, Bull. Tokyo Sci. Mus. 6: 105, 1943.

FIGS. 17–20

Basidiome annual, $50\text{--}80 \times 40\text{--}56 \times 24\text{--}38\ \text{mm}$, pileate-sessile, dimidiate to semicircular, corky, hard when dry. Pileus convex to plane, light to reddish or dark brown at the base (6D8, 6E8, 7E8, 8E8, 7F4), blackening when old, first adpressed tomentose, then glabrous, concentrically zoned with dark lines contrasted with different brown zones, also radially wrinkled to the margin, cracked with age. Margin thin to moderately thick, sterile, light yellow (4A4) to yellowish brown (5D8), entire or slightly incised to wavy. Hymenophore poroid, pores rounded, 3–4 per mm, in various tones of brown, cinnamon brown (6D6), cocoa brown (6E6), reddish brown (8E8, 8F8), dark reddish brown (8F6) to umber brown (6F6) in oldest specimens, entire to lacerate dissepiments; tubes 5–12 mm deep, cinnamon color (5D6), to brown (6E7) to dark reddish brown (8F6) with pale yellow (4A3) mycelia stuffed tubes in older specimens. Context up to 20 mm thick, chestnut (6F8) to dark brown (7F4), zonate, fibrous and lustrous, very hard when dry.

HYPHAL SYSTEM monomitic, generative hyphae simple septate, pale yellow to dark brown in KOH, simple to branched, thin- to thick-walled, $2.4\text{--}8\ \mu\text{m}$ diam. HYMENOPHORAL TRAMA with parallel to subparallel hyphae, pale yellow, yellowish brown to reddish brown in KOH, thin- to thick-walled, simple to slightly branched, $3.2\text{--}6.4\ \mu\text{m}$ wide. CONTEXTUAL TRAMA with two types of hyphae, one formed by parallel to subparallel hyphae, yellowish brown to reddish brown in KOH, simple, some scarcely branched, separated, with spaced septa, $5\text{--}8\ \mu\text{m}$ wide; the other type formed by interwoven hyphae contorted, branched, reddish brown to dark brown in KOH, with frequent septa, $2.4\text{--}5$

µm, they are mixed with the parallel hyphae. HYPHAL SETAE abundant in hymenophoral trama, rare in context, up to 450 µm long, 8–12 µm wide, parallel to hymenial layer, but occasionally projecting downward up to 120 µm past hymenium, dark brown in KOH, broadly ellipsoid, pale yellow, golden yellow to rusty brown in KOH, inamyloid, thin- to thick-walled, smooth.

ECOLOGY, RANGE AND DISTRIBUTION — The Mexican specimen was collected during September on dead oak in a *Quercus* forest. This species has been reported from Africa (Ryvarden & Johansen 1980), Arizona in U.S.A. (Gilbertson & Ryvarden 1986), Brazil (Loguercio-Leite & Wright 1991), Japan (Nuñez & Ryvarden 2000) and from Uruguay to Costa Rica (Ryvarden, 2004). This is the first record to Mexico in Sonora State.

REPRESENTATIVE SPECIMEN EXAMINED — MEXICO. SONORA: Municipality of Álamos, LA CAÑITA (108°38'59.52"W 26°59'32.6"N) elev. 657 m, 15.IX.2006, R. Valenzuela 13079 (ENCB).

COMMENTS — This species is characterized by the zonate pileus with alternating brown and black zones, hard, lustrous context, conspicuous hyphal setae and basidiospore color, shape and size. Other *Inonotus* species with pileate basidiomata, hyphae setae, and *Quercus* habit are *I. glomeratus* (Peck) Murrill, *I. quercustris* M. Blackw. & Gilb., and *I. rickii* (Pat.) D.A. Reid. The first species is separated from *I. patouillardii* by azonate pileus, abundant hymenial setae, and paler spores; the second species is distinguished by its larger, hirsute basidiomata, larger basidiospores, and growth in living *Quercus*; the third species has chlamydospores in context and produces a *Ptychogaster* anamorph. Ryvarden & Johansen (1980) and Nuñez & Ryvarden (2000) mention that specimens from Africa and Japan possess hymenial setae while American specimens lack setae.

Inonotus tropicalis (M.J. Larsen & Lombard) T. Wagner & M. Fisch., Mycologia 94: 1009, 2002. FIGS. 21–24

Basidiome annual to biennial, resupinate, effused, reaching 100–350 × 50–150 × 3–5 mm, adnate, corky. Margin sterile, up to 2 mm wide, sulfur yellow (1A5), brownish yellow (5C7), golden brown (5D7) to yellowish brown (5E8), velvety to matted. Hymenophore poroid, pores circular to angular, 7–9 per mm, golden brown (5D7), yellowish brown (5E8), rust brown (6E8) to reddish brown (8E8), dark brown in oldest specimens (7F6), edges rather wide and entire; tubes up to 4 mm long in a layer, fragile to tough, concolorous to the pores. Context up to 1 mm thick, yellowish brown (5E8) to reddish brown (8E8), fibrous and soft.

HYPHAL SYSTEM pseudodimitic, generative hyphae simple septate, hyaline, pale yellow to yellowish brown in KOH, simple to slightly branched, thin- to thick-walled, 2.4–4 µm diam; skeletal hyphae without or very distant septa, yellowish brown to reddish brown, unbranched, thick-walled, 3.2–5 µm diam.

HYMENOPHORAL TRAMA with parallel to subparallel hyphae, generative hyphae hyaline, pale yellow to yellowish brown in KOH, thin- to thick-walled, simple to slightly branched, frequent to spaced septa, 2.4–4 µm wide; skeletal hyphae without or simple septate very distant, yellowish brown to reddish brown in KOH, unbranched, thick-walled, 3.2–5 µm diam. CONTEXTUAL TRAMA with slightly interwoven hyphae, generative hyphae pale yellow to yellowish brown in KOH, simple to scarcely branched, with spaced septa, thick-walled, 2.4–4 µm wide; skeletal hyphae without or very distant septa, yellowish brown to reddish brown in KOH, unbranched, thick-walled, 3.2–5 µm diam. HYMENIAL SETAE very abundant, occurring in clusters or fascicles around pore apertures, 12–24 × 5–8 µm, ventricose to subulate, projecting up to 8 µm, reddish brown to dark brown in KOH, thick-walled (up to 1.6 µm thick). BASIDIA 6.4–10 × 4–5.6 µm, clavate, tetra-spored, hyaline to pale yellow in KOH. Basidiospores 3.2–4.8 × 2.4–4 µm, hyaline and subglobose when young, ovoid to broadly ellipsoid, pale yellow, golden yellow to pale yellowish brown in KOH when mature, inamyloid, thin-walled, smooth.

ECOLOGY, RANGE AND DISTRIBUTION — The Mexican specimens grow in September on dead angiosperm wood in caducifolious tropical forest. This species has been reported from Brazil and Costa Rica (Larsen & Lombard 1988; Larsen & Cobb-Poulle 1990) and Mississippi in U.S.A. (Lowe 1966; as *Poria rickii* Bres.) This is the first record to Mexico in Sonora State.

REPRESENTATIVE SPECIMEN EXAMINED — MEXICO. SONORA: Municipality of Álamos, EL AGUAJE (108°45'48.9"W 26°56'45.9"N) elev. 452.2 m, 14.IX.2006, R. Valenzuela 13097 (ENCB).

COMMENTS — This species is characterized by a resupinate basidiome, small pores, small and abundant hymenial setae, and basidiospore color, size, and shape. It was described (as *Phellinus tropicalis*) by Larsen & Lombard (1988) with annual basidiome and two kinds of contextual hyphae, generative hyphae, and thick-walled, infrequently simple-septate skeletal hyphae. Lowe (1966) pointed out that *P. tropicalis* (as *Poria rickii*, a synonym) has an annual to biennial basidioma with a monomitic hyphal system with occasionally and inconspicuously simple-septate contextual generative, characters typical of *Inonotus*. Wagner & Fischer (2002) transferred *P. tropicalis* to *Inonotus* after phylogenetic analysis of *Phellinus* and *Inonotus* derived from rDNA nLSU sequence data.

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Literature cited

- Bondartseva MA, Herrera S. 1980. Posición taxonómica y sistema del género *Phellinus* Quél. Mikologiya i Fitopatologiya 14: 3–9.
- Cifuentes J, Villegas M, Pérez-Ramírez L. 1986. Hongos. 55–64, in A Lot, F Chiang (eds.), Manual de herbario. Consejo Nacional de la Flora de México, A.C., México.
- Corner EJH. 1991. Ad Polyporaceas VII. The xanthochroic polypores. Beihefte Zur Nova Hedwigia 101: 1–175.
- Dai YC. 1999. *Phellinus* sensu lato (*Aphylllophorales*, *Hymenochaetaceae*) in East Asia. Acta Botanica Fennica 166: 1–115.
- Donk MA. 1948. Notes on Malesian fungi 1. Bulletin of the Botanic Gardens Buitenzorg Series III. 17: 473–482.
- Gilbertson RL, Ryvarden L. 1986. North American Polypores. *Abortiporus-Lindteria*. Vol. 1. Fungiflora, Oslo.
- Gilbertson RL, Ryvarden L. 1987. North American Polypores. *Megasporoporia-Wrightoporia*. Vol. 2: Fungiflora. Oslo, Noruega. 843 pp.
- Groposo C, Loguercio-Leite C, Góes-Neto A. 2007. *Fuscoporia* (*Basidiomycota*, *Hymenochaetales*) in Southern Brazil. Mycotaxon 101: 55–63.
- Holmgren PK, Holmgren NH. 1998. Index Herbariorum. <http://sciweb.nybg.org/science2/IndexHerbariorum.asp>. June 2009.
- Kornerup A, Wanscher JH. 1978. Methuen handbook of colour. 3th ed. Eyre Methuen, London.
- Larsen MJ, Lombard FF. 1988. Studies in the genus *Phellinus* I. The identity of *Phellinus rickii* with notes on its facultative synonyms. Mycologia 80: 72–76.
- Larsen MJ, Cobb-Pouille LA. 1990. *Phellinus* (*Hymenochaetaceae*). A survey of the world taxa. Synopsis Fungorum 3: 1–206.
- Larsson KH, Parmasto E, Fischer M, Langer E, Nakasone KK, Redhead SA. 2006. *Hymenochaetales*: a molecular phylogeny of the hymenochaetoid clade. Mycologia 98: 926–936.
- Loguercio-Leite C, Wright JE. 1991. Contribution to a biogeographical study of the austro-american xylophilous polypores (*Aphylllophorales*) from Santa Catarina Island, SC, Brazil. Mycotaxon 41: 161–166.
- Loguercio-Leite C, Wright JE. 1995. The genus *Phellinus* (*Hymenochaetaceae*) on the Island of Santa Catarina, Brazil. Mycotaxon 54: 361–388.
- Lowe JL. 1966. *Polyporaceae* of North America. The genus *Poria*. Syracuse State University College of Forestry. Technical Publications 90. New York.
- Murrill WA. 1907. (*Agaricales*) *Polyporaceae*. North American Flora 9: 1–131.
- Núñez M, Ryvarden L. 2000. East Asian Polypores. Vol. 1. *Ganodermataceae* and *Hymenochaetaceae*. Synopsis Fungorum 14: 1–168.
- Parmasto E. 2000. New taxa and new combinations in hymenochaetoid fungi (hymenomycetes). Folia Cryptogamica Estonica 37: 55–66.
- Parmasto E. 2001. Hymenochaetoid fungi (*Basidiomycota*) of North America. Mycotaxon 79: 107–176.
- Ryvarden L. 1991. Genera of polypores. Nomenclature and taxonomy. Synopsis Fungorum 5: 1–363.

- Ryvarden L. 2004. Neotropical Polypores. Introduction, *Ganodermataceae* & *Hymenochaetaceae*. Synopsis Fungorum 19: 1–229.
- Ryvarden L, Johansen I. 1980. A preliminary polypore flora of East Africa. Fungiflora, Oslo.
- Wagner T, Fischer M. 2002. Proceedings towards a natural classification of the worldwide taxa *Phellinus* s.l. and *Inonotus* s.l., and phylogenetic relationships of allied genera. Mycologia 94: 998–1016.

***Tuber pseudoexcavatum* versus *T. pseudohimalayense* — new data on the molecular taxonomy and mycorrhizae of Chinese truffles**

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Abstract — The study of Chinese *Tuber* species available in European markets began 14 years ago. *T. pseudohimalayense* was proposed as a new species but has been questioned. We evaluated the validity of *T. pseudohimalayense* by comparing the molecular genetics and ectomycorrhizal morphology of *T. pseudohimalayense*, *T. pseudoexcavatum*, and *T. indicum*. As a result of these studies, we propose *T. pseudoexcavatum* to represent a synonym of *T. pseudohimalayense*.

Key words — *Tuberaceae*, hypogeous fungus

Introduction

Several Chinese *Tuber* species have become commercially available in European markets in recent decades. *Tuber pseudohimalayense* G. Moreno et al. (1997) and *T. pseudoexcavatum* Y. Wang et al. (1998) were found in Spanish markets and proposed as new species.

Tuber pseudoexcavatum has been regarded as common, as confirmed by molecular phylogenic and taxonomic studies (Riousset et al. 2001, Zhang et al. 2005, Wang et al. 2006b). *Tuber pseudohimalayense* appeared to be much rarer. Di Massimo et al. (1998) found *T. pseudohimalayense* in Chinese truffle shipments in Italian truffle markets, and Zhang et al. (2005) and Wang et al. (2006a) cited it from China.

Wang & Hall (2001), who reported that *T. pseudohimalayense* closely resembles *T. sinense* K. Tao & B. Liu, proposed using molecular tools to clarify the taxonomy of this and other truffles from southwestern China. Zhang et al. (2005) synonymized *T. pseudohimalayense* and *T. sinense* with *T. indicum* Cooke & Massee based on morphological studies and rDNA ITS sequence analyses.

Wang et al. (2006a) studied the genetics and phylogeography of Chinese *Tuber* species. On the basis of the ITS and β -tubulin gene sequences they concluded that differences in the taxonomic characters of *T. indicum* Cooke & Massee, *T. sinense*, *T. pseudohimalayense*, and *T. himalayense* B.C. Zhang & Minter represented normal variations within a single species, *T. indicum*.

However, Zhang et al. (2005) and Wang et al. (2006a) were unable to study the *T. pseudohimalayense* holotype collection in the University of Alcalá Herbarium (AH 18331), which was unwilling to risk its loan to another country as the type consists of only one small piece of an ascoma (Moreno et al. 1997).

Comandini & Pacioni (1997) and Zambonelli et al. (1997) synthesized *T. indicum* ectomycorrhizae. In the University of Alcalá (Spain), *T. pseudohimalayense* and *T. pseudoexcavatum* ectomycorrhizae were also synthesized using spores from ascomata of the type collections of both species (holotype of *T. pseudohimalayense* and an isotype of *T. pseudoexcavatum* AH 18387). We found that *T. pseudohimalayense* ectomycorrhizae had a morphological affinity with *T. indicum* ectomycorrhizae; however, they even more resembled *T. pseudoexcavatum* ectomycorrhizae (Manjón et al. 1998, García-Montero et al. 2008).

We here report results of genetic studies of ascomata from types of *T. pseudohimalayense* and *T. pseudoexcavatum*, plus samples of *T. indicum* and describe the morphology of *T. pseudohimalayense* ectomycorrhizae in comparison with those of *T. indicum* and *T. pseudoexcavatum*. Our aim was to assess the validity of *T. pseudohimalayense* and increase our knowledge of the genetics of Chinese *Tuber* taxa.

Material and methods

MATERIAL EXAMINED: *Tuber pseudohimalayense* (holotype, AH 18331) probably imported from China, January 1995; *Tuber pseudoexcavatum* (isotype, AH 18387) imported from China from pine forests in Yunnan, January 1995; *Tuber indicum* (AH 18329), probably imported from China, January 1995; *Tuber indicum* holotype (K 39493) and *Tuber himalayense* isotype (K 32236) from the Royal Botanic Gardens, Kew; and samples of *Tuber sinense* (personal collection provided by Y. Wang, with immature ascospores).

MOLECULAR METHODS: Total DNA from *T. pseudohimalayense* and its putative closest relatives among Chinese *Tuber* species (TABLE 1) was extracted by means of

TABLE 1. Samples included in molecular comparisons

SPECIES	HERBARIUM CODE	TYPE COLLECTION	ITS GENBANK#	28S LSU GENBANK#	MTLSU GENBANK#
<i>T. pseudohimalayense</i>	AH 18331	Holotypus		FJ233104	FJ792795
<i>T. pseudoexcavatum</i>	AH 18387	Isotypus		FJ233103	FJ792794
<i>T. indicum</i>	AH 18329	–	FJ233102	FJ233102	

the MasterPure™ DNA Purification Kit (Epicentre Biotechnologies, Madison, US) following the manufacturer’s instructions. An additional piece of *T. pseudohimalayense* was included to sonicate spores for two periods of 60s in a Cell Disruptor B15 sonifier (Branson). The sample was checked periodically under the microscope to insure spore rupture. After extraction, 1.5 µl resuspended DNA was added to a 50µl PCR mixture with the following concentrations: 1u EcoTaq DNA polymerase with 1× EcoTaq Buffer (Ecogene), MgCl₂ 2mM, DNTPs 0.2 mM each. 28S LSU primers U2 (5’ – GAC TCC TTG GTC CGT GTT – 3’, Sandhu et al. 1995) and LR1 (5’ – GCA TAT CAA TAA GCG GAG GA – 3’, Van Tuinen et al. 1998), and mitochondrial large ribosomal subunit (mtLSU) primers ML3 (5’ – GCT GGT TTT CTA CGA AAC ATA TTT AAG – 3’, White et al., 1990) and ML4 (5’ – GAG GAT AAT TTG CCG AGT TCC – 3’, White et al., 1990) were added at 0.5µM each. PCR reactions were performed under a program consisting of a hot start at 95 °C for 5 min, five cycles at 94 °C, 50 °C and 72 °C (45, 30 and 45 sec, respectively), followed by 30 cycles at 94 °C, 54 °C and 72 °C (45, 30 and 45 sec, respectively) and a final 72 °C step for 10 min. *T. indicum* was amplified once, while *T. pseudoexcavatum* and *T. pseudohimalayense* were amplified twice. PCR products were checked in a 1% agarose gel prior to purification in Sephadex G-50 superfine columns and sequenced in an ABI 3130 sequencer with BigDye Terminator 3.1 Cycle Sequencing Kit (Applied Biosystems, Foster City, US) with the same amplification primers as in the sequencing reaction. The sequences were then loaded in MEGA software and visually compared to chromatograms to check for peak reading failures. Sequences were entered into GenBank under the codes specified in TABLE 1.

MICROSCOPY: For light microscopy, the hand-sectioned samples were mounted in Hoyer’s medium. For scan electron microscopy (SEM), the material was rehydrated in concentrated ammonium hydroxide (28–30%) for 30 min, dehydrated in aqueous ethanol (70%) for 30 min, fixed for 2 hr in pure ethylene glycol dimethyl ether (= 1,2-dimethoxymethane) and finally immersed in pure acetone for at least 2 hr, followed by critical point drying and spattering with gold-palladium. This technique uses very little material. The micrographs were taken at the University of Alcalá with a Zeiss DSM–950 SEM. Spore were measured under the oil immersion objective of a light microscope including the ornamentation (Moreno et al. 1997).

DESCRIPTIONS OF ECTOMYCORRHIZAE: We synthesized *T. pseudohimalayense* ectomycorrhizae with *Quercus ilex* subsp. *ballota* (Desf.) Samp. using spores from the type by applying Bencivenga’s (1982) method as modified by Manjón & García-Montero (1996). Plants were grown under controlled environmental conditions in a glasshouse

in the Juan Carlos I Royal Botanical Garden at the University of Alcalá (Madrid, Spain). Mycorrhization of each plant was expressed as the number of *Tuber* mycorrhizae over the total number of non-mycorrhizal tips (Bencivenga et al. 1987). The ectomycorrhiza color was described following the Munsell standard soil color charts (Munsell 1976). Ectomycorrhizae were identified with a stereoscopic microscope (photo-Leica WildMZ8) and a light microscope (photo-Leica LeitzDMRB) as recommended by Agerer (1987–2002), Zambonelli et al. (1993), and Granetti (1995). Mycorrhizae characters of related species were taken from the literature (TABLE 3).

Results

MOLECULAR ANALYSIS: Amplified partial 28S LSU and mtLSU sequences from the manually extracted samples of *Tuber pseudoexcavatum* and *T. pseudohimalayense* and the sonicated sample of *T. pseudohimalayense* are identical to each other but different from *T. indicum*. Further validation by means of rDNA ITS amplification with primers ITS5 (5' – GGA AGT AAA AGT CGT AAC AAG G– 3', White et al., 1990) and ITS4 (5' –TCC TCC GCT TAT TGA TAT GC– 3', White et al., 1990) was unsuccessful for all samples except *T. indicum*, probably due to sample age or deterioration. Comparison of the *T. indicum* ITS sequence to public databases by means of nucleotide BLAST search in NCBI web service (<http://www.ncbi.nlm.nih.gov/>) showed almost complete identity (99%) with the other *T. indicum* sequences. These indicate *T. pseudoexcavatum* and *T. pseudohimalayense* belong to a single taxon, unrelated to *T. indicum* (FIGS. 1–2).

MORPHOLOGY: Because the molecular analysis indicated that *T. pseudohimalayense* and *T. pseudoexcavatum* represented the same species, we re-examined their macro and microscopic characters. The holotype fragment of *T. pseudohimalayense* has a brown peridium and a slight excavation similar to that of the *T. pseudoexcavatum* ascoma, characters that were overlooked when *T. pseudohimalayense* was originally described. The *T. pseudohimalayense* holotype shows 1–7 spored asci and 1–8 spored asci occur in the species as a whole. Peridium and spores of the two species do not differ (TABLE 2; FIGS. 3–4).

ECTOMYCORRHIZAE: The root tips of *Q. ilex* subsp. *ballota* seedlings inoculated with *T. pseudohimalayense* averaged 50% mycorrhization (standard deviation ± 17). No ectomycorrhizae formed by other fungi were detected. *Tuber pseudohimalayense* ectomycorrhizae (FIG. 5) were concentrated in the proximal and median part of the root system. Therefore, the techniques for inoculating and producing mycorrhized plants, as well as the substrates used, gave good results for this truffle species. Macro- and micromorphology of ectomycorrhizae of *T. melanosporum* Vittad. and four Chinese *Tuber* spp. are compared in TABLES 3–4.

T.IND AY294006	GGCCAATCTATAGGTTGACC	TCGCCTTAAGCTTATGGTAT	AGATAAAAGTAACGGCCTCT
T.PSEX FJ233103	.....	.....	.....
T.PSHIM FJ233104	.....	.....	.....G.
T.IND AY294006	AAGTTTATTAAACCTAAAGG	ACTAAACGATGAGAAAACCT	TGTTTATAAAGTAATAACCT
T.PSEX FJ233103	.....	.....	.....
T.PSHIM FJ233104	.....	.....	.....
T.IND AY294006	TTAAATTTTAAACATTCTG	GGCTCGCACGCCCTCACTCT	CTTTAGGAGTGAGTGATCGC
T.PSEX FJ233103	.....	..G.....	.....A.....
T.PSHIM FJ233104	.....	..G.....	.....A.....
T.IND AY294006	GCCCCAATATCTGATGTAAA	TAATAAGTGATGAAGA	
T.PSEX FJ233103	.....	.....
T.PSHIM FJ233104	.....	.....C....	

FIG 1. Partial alignment of the mitochondrial large ribosomal subunit (mtLSU) of the studied samples. Conserved bases (.), deleted bases (-).

T.IND FJ233102	GCATATCAATAAGCGGAGGA	AAAGAAACCAACAGGGATTG	CCCTAGTAACGGCGAGTGAA
T.PSEX FJ233103	.....	.....	..TC.....
T.PSHIM FJ233104	.....	.....	..TC.....
T.IND FJ233102	GCGGCAAAAGCTCAAATTTG	AAATCTGGCATCTTTGGTGT	CCGAATTGTAATTTGGAGAG
T.PSEX FJ233103	.....	.....A..C..C.....	T...G.....
T.PSHIM FJ233104	.....	.....A..C..C.....	T...G.....
T.IND FJ233102	GCAACTTCAGGTAGGACCCA	GTCTATGTTCTTGAACAG	GACGTCATAGAGGTGAGAA
T.PSEX FJ233103	.....A.T...	..C.....	..G.....
T.PSHIM FJ233104	.....A.T...	..C.....	..G.....
T.IND FJ233102	TCCCGTTCTTGACTGGATGT	TCTTGCTAGTATGTAGTGCC	TTCTACGAGTCGAGTTGTTT
T.PSEX FJ233103	.....TG..G.....	..TC.A.....C...C...	.....
T.PSHIM FJ233104	.....TG..G.....	..TC.A.....C...C...	.....
T.IND FJ233102	GGAATGCAGCTCAAAATGG	GTGGTAAATTCATCTAAAG	CTAAATATTGGCGAGAGACC
T.PSEX FJ233103	.....	.....	.....
T.PSHIM FJ233104	.....	.....	.....
T.IND FJ233102	GATAGCGCACAGTAGAGTG	ATCGAAAGATGAAAAGCACT	TTGAAAATAGAGTCAAAAAG
T.PSEX FJ233103	.....	.....	.....
T.PSHIM FJ233104	.....	.....	.....
T.IND FJ233102	TACGTGAAATTGTTGAAAGG	GAAGCGCTTGAGACCAGACT	CAGCCTTTGGCAAACAAGTG
T.PSEX FJ233103	.....	.....	.....TA.
T.PSHIM FJ233104	.....	.....	.....TA.
T.IND FJ233102	TCCTTCTGGGCAGTGCACTT	GCCTCCGGGTTGGGCCAGTA	TCAGTTAGGATGGTAGGAGA
T.PSEX FJ233103	.....TA..ATT.....	..T..T-...C.....C.	.....
T.PSHIM FJ233104	.....TA..ATT.....	..T..T-...C.....C.	.....
T.IND FJ233102	AAGGCTAGGGGAATGTGACT	CCTATCCGGAGTGTTATAGA	CCCTGGCGTCATGCTACCTG
T.PSEX FJ233103	.....T.G..AA.....	..A..TT.....	TT.CA.....T..A
T.PSHIM FJ233104	.....T.G..AA.....	..A..TT.....	TT.CA.....T..A
T.IND FJ233102	TCCTTGACTGTGGACCGCGC	GTTAGCTAGGATACTGGCGT	AATGGTCTTCAGCGGCCCGT
T.PSEX FJ233103	.....-.....	T..G.....G....A.	.....
T.PSHIM FJ233104	.....-.....	T..G.....G....A.	.....
T.IND FJ233102	CTTGAAACACGGACAACGGA	GTC	
T.PSEX FJ233103	.....	...
T.PSHIM FJ233104	.....	...

FIG. 2. Partial alignment of the genomic large ribosomal subunit (nrLSU 28S) of the studied samples. Conserved bases (.), deleted bases (-).

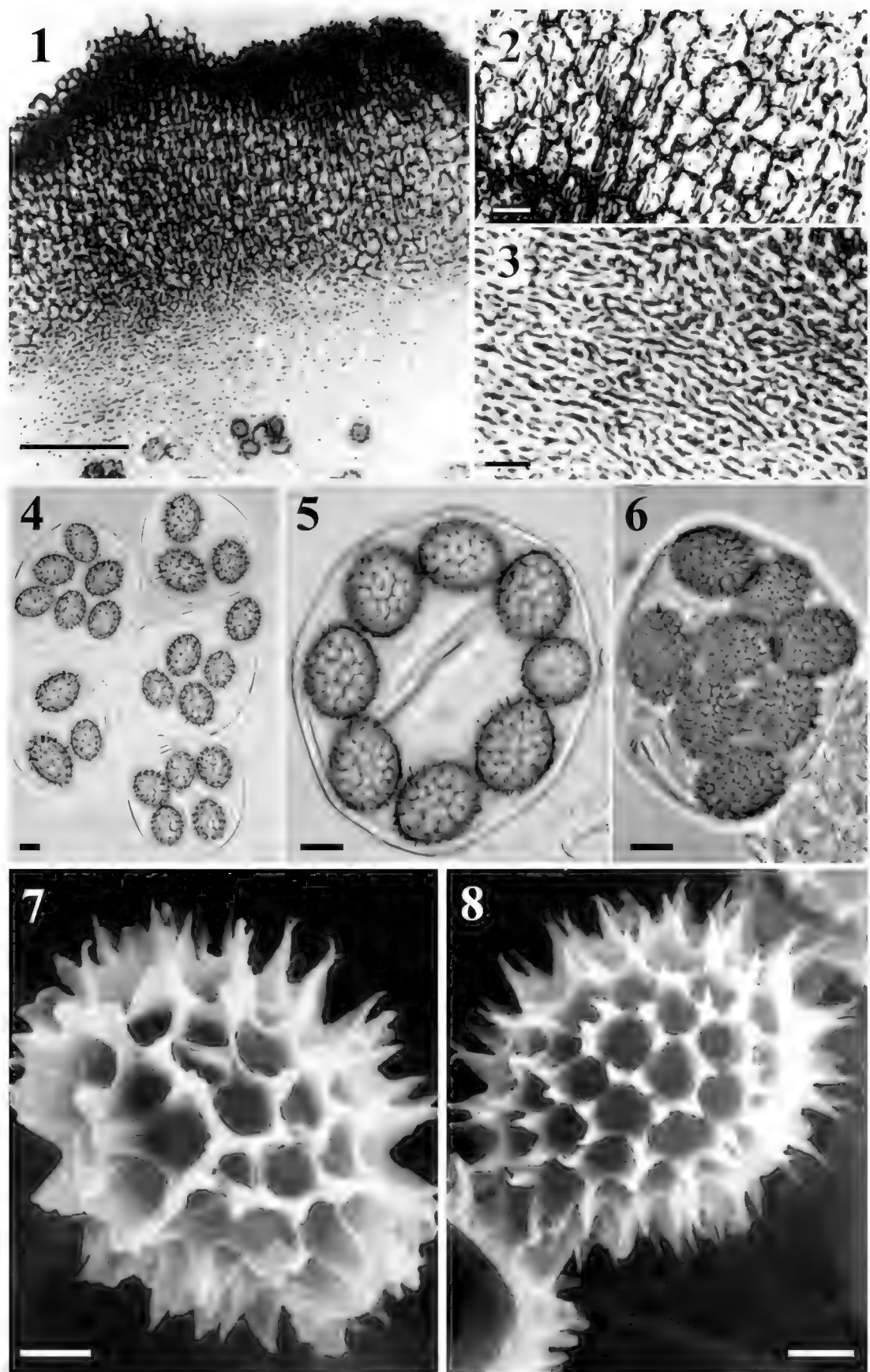


FIG. 3. *Tuber pseudoexcavatum* (Wang et al. 1998). 1) Detail of the external covering of the peridium. 2) Thick-walled globose cells of the external covering of the peridium. 3) Plectenchymal cells of the internal covering of the peridium. 4–6) Globose ascus with 3 to 8 ascospores, where the spiny-reticular ornamentation is apparent. 7–8) Thorny reticulations of spores, under the S.E.M.

(Bars: 1 = 100 μm ; 2 = 10 μm ; 3 = 20 μm ; 4–6 = 10 μm ; 7–8 = 5 μm).

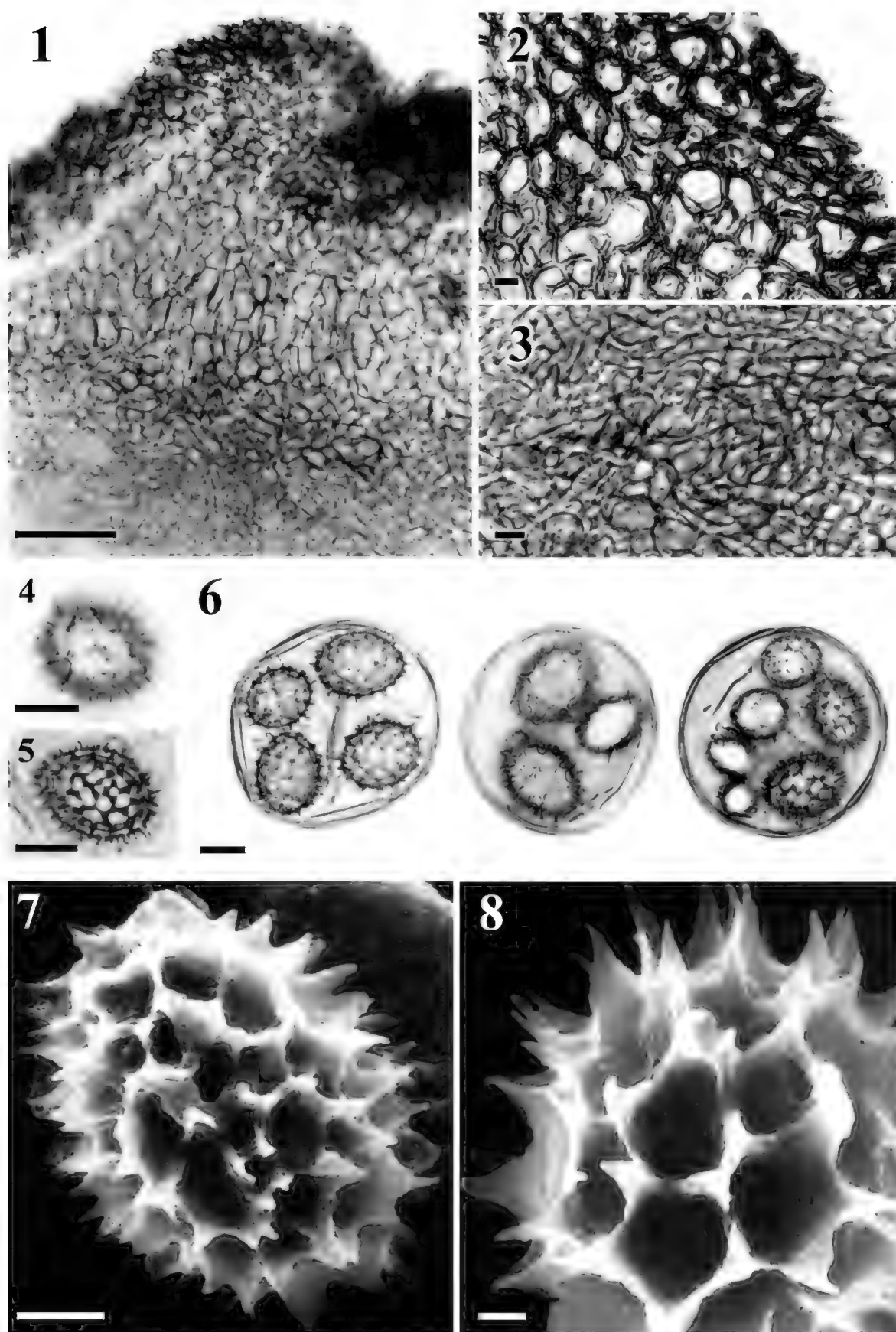


FIG. 4. *Tuber pseudohimalayense* (Moreno et al. 1997). 1) Detail of the external covering of the peridium. 2) Thick-walled globose cells of the external covering of the peridium. 3) Plectenchymal cells of the internal covering of the peridium. 4–5) Ascospores, where the spiny-reticular ornamentation is apparent. 6) Globose ascus with 3 to 7 ascospores. 7–8) Thorny reticulations of spores, under the S.E.M.

(Bars: 9 = 100 μm ; 10 = 20 μm ; 11–14 = 10 μm ; 15 = 5 μm ; 16 = 2 μm).

TABLE 2. Comparison of fruit body characters in Chinese *Tuber* species

SPECIES	<i>T. indicum</i> ¹	<i>T. himalayense</i> ¹	<i>T. pseudo-himalayense</i> ²	<i>T. pseudo-excavatum</i> ³
ASCOCARP	globose to ellipsoidal	+/- globose	subglobose	subglobose, deeply excavate
COLOR AND SURFACE	black or slightly greyish	black	warts black (+/- pyramidal, wide, flat)	brown to brown-orange, coarsely warted
PERIDIUM (µm)	550–700	700–800	200–500 broad	290–500 thick
ASCI (NUMBER)	(1–)3–5(–6)	(1–)2–4(–5)	1–7	1–8
ASCOSPORES (µm, including ornamentation)	ellipsoid 30–42 × 23–32	ellipsoidal to globose 28–45 × 23–40	ellipsoidal 18–35 × 16–30	ellipsoidal 29–33 × 21–24
ORNAMENTATION	spines, often slightly hooked	variable, most reticulate, occ. spiny	spines in netted reticulum	spines (5–8 µm tall) in reticulation

¹ Zhang & Minter (1988); ² Moreno et al. (1997); ³ Wang et al. (1998).

Description of *Tuber pseudohimalayense* ectomycorrhizae

MYCORRHIZAE in youth slightly club-shaped to almost cylindrical and lacking branches, with age often becoming pinnate branched in a monopodial-pinnate pattern; unbranched ends ≤ 1500 µm × 180 µm, straight; dark brown (7.5 YR 6/6) mycorrhizal tips color; surface smooth with long cystidia especially on the tip; rhizomorphs absent (FIG. 5).

CYSTIDIA sinuous to straight, yellowish; diameter: 2–3.3 µm; septa distance: 20–35 µm; hyphal smooth; often branching near base, with 30% of the cystidia branched in approx. 90° angle.

OUTER MANTLE pseudoparenchymatous, composed of pseudocells with very variable form from irregular polygonal to sinuous cells. Surface extremely irregular with puzzle-like appearance; hyphal pseudocells: (10–)12–30(–32) × (4–)5–12(–13) µm. Inner mantle with a similar irregular and puzzle-like appearance. Total mantle thickness 11–35 µm.

HARTIG NET present in 2–3 rows of host cortical cells.

Discussion

Ectomycorrhizal fungal diversity is an increasingly complex patchwork (Rinaldi et al. 2008), and *Tuber*, especially in its Chinese range, is not an exception. Moreno et al. (1997) and Di Massimo et al. (1998) proposed *T. pseudohimalayense* as a species characterised microscopically by its peculiar, thick-walled, dark brown ascospores, having an ornamentation of spines with broad basal connections

TABLE 3. Comparison of ectomycorrhizal morphology in Chinese Tuber species observed in international markets

	SPECIES	T. melanosporum ¹	T. indicum ²	T. himalayense ²	T. pseudoexcavatum ³	T. pseudohimalayense
Host		Quercus pubescens, Corylus avellana, Pinus sylvestris	Quercus pubescens, Q. cerris	Quercus pubescens	Quercus ilex subsp. ballota	Quercus ilex subsp. ballota
RAMIFICATION		simple & clavate with round apex, or monopodial- pinnately branched	simple & monopodial-pinnate or dichotomous branched	mostly unbranched; also branched & monopodial- pinnate	sl.clavate to almost cylindrical & unbranched when very young or branched & monopodial-pinnate	sl. clavate to almost cylindrical & unbranched when very young or branched & monopodial-pinnate
UNRAMIFIED ENDS (length)		200–4000 µm long	150–1620 µm long	235–1200 µm long	≤ 2500 µm long	≤ 1500 µm long
(diameter)		2300–450 µm diam	1200–540 µm diam	1500–250 µm diam	≤ 240 µm diam	≤ 180 µm diam
(color) ⁴		dark amber to ochre	ochreous-amber 7.5 YR 6/6	ochreous-amber 10 YR 5/8	dark brown 7.5 YR 6/6	dark brown 7.5 YR 6/6
LONG CYSTIDIA (on smooth surface)		primarily on tip	loose, primarily on tip, less abundant in age	loose, primarily on outer surface, less abundant in age	primarily on tip	primarily on tip

¹ Granetti (1995) and Zambonelli et al. (1993); ² Zambonelli et al. (1997) and/or Comandini & Pacioni (1997); ³ García-Montero et al. (2008); ⁴ Munsell (1976) standard soil color charts.

that form a regular net reticulum composed of variably sized meshes across the whole spore surface. The *T. pseudohimalayense* holotype presents a peridium of 200–500 µm, thinner than that of *T. indicum* (550–700 µm), *T. himalayense* (700–800 µm), and *T. sinense* (550–1300 µm). The cell morphology of the inner and outer layers of the peridium of *T. pseudohimalayense* differs from the other Chinese truffles (see the photographs and descriptions of Manjón et al. 1995; Di Massimo et al. 1996, 1998; Moreno et al. 1997). Finally, *T. pseudohimalayense* holotype asci (1–7 spored) generally contain more spores than *T. indicum*, with 3–5(–6) spored asci, *T. himalayense* with 2–4(–5) spored asci, and *T. sinense* with 1–4 spored asci (TABLE 2).

When proposing the new Chinese truffle taxa, we did not examine the differences between *T. pseudohimalayense* and *T. pseudoexcavatum* in any further detail, as their ascomata appeared so very different (TABLE 2). This important omission was shown in the description of *T. pseudoexcavatum*, which reports only that its ascomata differ from *T. sinense*, *T. gigantosporum* Y. Wang & Z.P. Li, *T. indicum*, *T. himalayense*, and *T. pseudohimalayense* in their excavate ascomata and their 8-spored asci. In TABLE 2 and FIGURES 3 and 4, we summarise the taxonomical characters of the *T. pseudohimalayense* holotype versus the *T. pseudoexcavatum* holotype (Moreno et al. 1997, Wang et al. 1998). We now can confirm the strong resemblance of the *T. pseudohimalayense* and *T. pseudoexcavatum* holotypes, except that *T. pseudohimalayense* asci range from 1–7 spored vs *T. pseudoexcavatum* that range from 1–8 spored.

Genetic studies on the type collections show that *T. pseudohimalayense* and *T. pseudoexcavatum* represent a single species that is different from *T. indicum*. Our study of voucher collections clearly indicates that *T. pseudohimalayense* was misidentified and provides additional molecular data on the *T. pseudoexcavatum* holotype. 28S LSU and mtLSU sequences were obtained instead of ITS, because the latter failed to be amplified for the *T. pseudohimalayense* holotype, probably due to its poor state of preservation.

Our present proposal of conspecificity of *T. pseudohimalayense* and *T. pseudoexcavatum* is further confirmed by the morphological similarity of their ectomycorrhizae, which are clearly distinguishable from *T. indicum* ectomycorrhizae (TABLES 3–4): they are thinner and darker than *T. indicum* ectomycorrhizae, and their outer mantle pseudocells are much larger and more often irregular and sinuous (puzzle form) than those of *T. indicum*.

Accordingly we propose *T. pseudoexcavatum* to be a synonym of the earlier named *T. pseudohimalayense*:

Tuber pseudohimalayense G. Moreno, Manjón, J. Díez & García-Mont.,
in Moreno et al., Mycotaxon 63: 218 (1997).
= *T. pseudoexcavatum* Y. Wang, G. Moreno, Riouset, Manjón & G.
Riouset, in Wang et al., Cryptogamie Mycologie 19: 115 (1998).

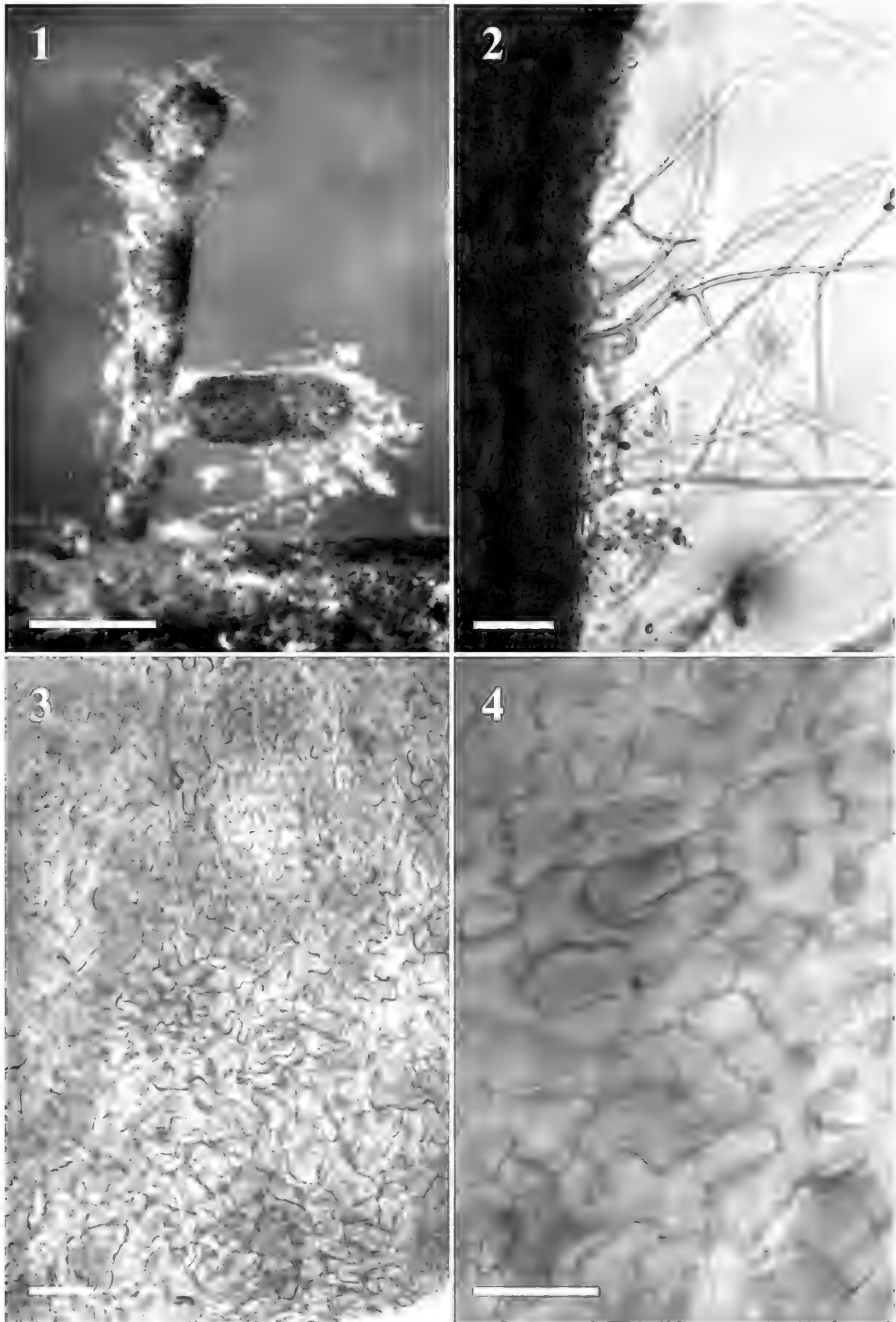


FIG. 5. Ectomycorrhizae of *Tuber pseudohimalayense*. 1) Macroscopic appearance of ectomycorrhiza (50×). 2) Detail of cystidia with right angle-like ramifications (400×). 3) Outer surface of the mantle appearance with a general feature of very irregular puzzle-like shape (100×). 4) Hyphal pseudocells of the outer surface of the mantle with polygon-shaped pseudocells alternating with cells with a sinuous form (1000×)

(Bars: 1 = 500 μm ; 2–4 = 10 μm).

TABLE 4. Comparison of ectomycorrhizal anatomy in Chinese *Tuber* species observed in international markets

SPECIES	<i>T. melanosporum</i> ¹	<i>T. indicum</i> ²	<i>T. himalayense</i> ²	<i>T. pseudoexcavatum</i> ³	<i>T. pseudohimalayense</i>
MANTLE SURFACE PATTERN (pseudo-parenchymatous)	Puzzle-like: individual cells rounded, with well-defined irregular lobes	Puzzle-like, very heterogeneous, individual pseudocells of two types: rounded & regular and polygonal [mostly smaller & less lobed than in <i>T. melanosporum</i>]	Puzzle-like, rather homogeneous; individual pseudocells rectangular, more or less elongated, frequently ramified	Puzzle-like, quite regular, homogeneous; individual pseudocells s-shaped (sinuous)	Puzzle-like, extremely irregular; individual pseudocells of two types: 4–5 sided polygon-shaped and s-shaped (sinuous)
HYPHAE (exterior dimensions)					
Length	10.6 (± 2.4) µm (mean)	(8–) 10–16 (–24) µm	(7–) 10–16 (–18) µm	(8–) 10–25 (–26) µm	(10–) 12–30 (–32) µm
Width	4.6 (± 1) µm (mean)	(4–) 5–6 (–10) µm	4–6 µm	(5–) 6–16 (–17) µm	(4–) 5–12 (–13) µm
CYSTIDIA Form	≤ 300 µm long; straight; frequent ~90° and 45° ramifications	≤ 300 µm long; frequent ~90° ramifications	often very long, ≤ 300 µm; ~90° ramifications	very long, sinuous to straight, sectioned; 15% with frequent ~90° ramifications	very long, sinuous to straight, sectioned; 30% with frequent ~90° ramifications
Color	Hyaline	Pale yellow	–	Yellowish	Yellowish
Plinth diam	(2.8–)3.5(–4.4) µm (mean)	2–4(–8) ~90° [tip = 2–3(–6) µm]	2–3 µm	2–4 µm	2–3 µm
SEPTA DISTANCE		25–35 µm	20–40 µm	25–35 µm	20–35 µm

¹ Granetti (1995) and Zambonelli et al. (1993); ² Zambonelli et al. (1997) and/or Comandini & Pacioni (1997); ³ García-Montero et al. (2008).

Macro and microscopic differences initially observed between the *T. pseudohimalayense* and *T. pseudoexcavatum* holotypes can be explained by gaps in their fruitbody development, maturation stages, and perhaps by differences in the preservation treatments used in the commercial shipments of Chinese truffles. In short, to avoid potential ecological problems in Europe it is essential to know more about the taxonomy, genetics, and morphology of the mycorrhizae of Chinese truffles, so that public agencies can accurately monitor truffle-inoculated seedlings.

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Literature cited

- Agerer R. 1987–2002. Colour atlas of ectomycorrhizae. Einhorn-Verlag, Schwabsh-Gmund. 168 pp.
- Bencivenga M, Ferrara AM, Fontana A, Granetti B, Gregori G, Lo Bue G, Palenzona M, Rebaudengo E, Tocci A, Zambonelli A. 1987. Valutazione dello stato di micorrizazione di piante tartufigene. Proposta di un metodo. Ministero dell'Agricoltura e Foreste, Roma. 14 pp.
- Bencivenga M. 1982. Alcune metodiche di micorrizazione di piante forestali con il tartufo nero pregiato di Norcia o di Spoleto (*Tuber melanosporum* Vittad.). L'Informatore Agrario 38: 21155–21163.
- Comandini O, Pacioni G. 1997. Mycorrhizae of Asian black truffles, *Tuber himalayense* and *T. indicum*. Mycotaxon 63: 77–86.
- Di Massimo G, Bencivenga M, Tedeschini E, García-Montero LG, Manjón JL. 1998. Nuova specie di *Tuber* importata dall'oriente. Micologia Italiana 27: 13–18.
- Di Massimo G, García-Montero LG, Bencivenga M, Manjón JL. 1996. *Tuber indicum* Cooke et Masee, un tartufo orientale simile a *T. melanosporum* Vitt. Micologia & Vegetazione Mediterranea 11: 107–114.
- García-Montero LG, Di Massimo G, Manjón JL, García-Abril A. 2008. New data on ectomycorrhizae and soils of the Chinese truffles *Tuber pseudoexcavatum* and *T. indicum*, and their impact on truffle cultivation. Mycorrhiza 19: 7–14.
- Granetti B. 1995. Caratteristiche morfologiche, biometriche e strutturali delle micorrize di *Tuber* di interesse economico. Micologia Italiana 2: 101–117.

- Manjón JL, García-Montero LG. 1996. Síntesis micorrícica con esporas de *Tuber malenconii* y otros hongos con aplicación forestal y en la truficultura. Boletín Sociedad Micologica de Madrid 21: 397–400.
- Manjón JL, García-Montero LG, Di Massimo G. 1998. Mycorrhizal synthesis of *Tuber pseudohimalayense* and *T. pseudoexcavatum*, two truffles from Asia. p. 113, in Second International Conference on Mycorrhizae. ICOM II, Abstracts, 5 to 10 July 1998, Uppsala, Sweden.
- Manjón JL, Moreno G, Díez J, García-Montero LG. 1995. *Tuber indicum* Cooke & Massee en España: una especie comercializada con características similares a nuestra trufa negra. Boletín Sociedad Micologica de Madrid 20: 301–304.
- Moreno G, Manjón JL, Díez J, García-Montero LG, Di Massimo G. 1997. *Tuber pseudohimalayense* sp. nov. An Asiatic species commercialised in Spain, similar to Perigord truffle. Mycotaxon 63: 217–224.
- Munsell MD. 1976. Soil color charts. Kollmorgen Corporation, Baltimore. 32 pp.
- Rinaldi AC, Comandini O, Kuyper TW. 2008. Ectomycorrhizal fungal diversity: separating the wheat from the chaff. Fungal Diversity 33: 1–45.
- Riousset L, Riousset G, Chevalier G, Bardet MC. 2001. Truffles d'Europe et de Chine. Institut National de la Recherche Agronomique INRA, Paris. 181 pp.
- Sandhu GS, Kline BC, Stockman L, Roberts GD. 1995. Molecular probes for diagnosis of fungal infection. Journal of Clinical Microbiology 33: 2913–2919.
- Van Tuinen D, Zhao B, Gianinazzi-Pearson V. 1998. PCR studies of AM fungi, from studies to application. pp. 387–400, in Mycorrhiza Manual (A.Varma, ed.). Springer-Verlag, Berlin.
- Wang Y, Hall IR. 2001. *Tuber sinense* and other species from South-West China. IN Actes du Ve Congres International Science et Culture de la Truffe, Aix-en-Provence, 4–6 Mars 1999. Edited by Corvoisier M, Olivier JM, Chevalier G, Federation Francaise des trufficulteurs, Paris. pp. 115–116.
- Wang Y, Moreno G, Riousset L, Riousset G, Manjón JL, Riousset G, Fourré G, Di Massimo G, García-Montero LG, Díez J. 1998. *Tuber pseudoexcavatum* sp. nov. an chinese species commercialised in Spain, France and Italy with comments on chinese truffles. Cryptogamie Mycologie 19: 113–120.
- Wang Y, Tan ZM, Zhang DG, Murat C, Jeandroz S, Le Tacon F. 2006a. Phylogenetic and populational study of the *Tuber indicum* complex. Mycological Research 110: 1034–1045.
- Wang Y, Tan Z, Zhang DC, Murat C, Jeandroz S, Tacon F. 2006b. Phylogenetic relationships between *Tuber pseudoexcavatum*, a Chinese truffle, and other *Tuber* species based on parsimony and distance analysis of four different gene sequences. FEMS Microbiology Letters 259: 269–281.
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In PCR Protocols: A Guide to Methods and Applications. Edited by Innis MA, Gelfand DH, Sninsky JJ, White TJ. Academic Press, New York. pp. 315–322.
- Zambonelli A, Salomoni S, Pisi AM. 1993. Caratterizzazione anatomo-morfologica delle micorrize di *Tuber* spp. su *Quercus pubescens* Willd. Micologia Italiana 22: 73–90.
- Zambonelli A, Tibiletti E, Pisi AM. 1997. Caratterizzazione anatomo-morfologica della micorriza di *Tuber indicum* Cooke & Massee su *Pinus pinea* L. and *Quercus cerris* L. Micologia Italiana 1: 29–36.
- Zhang BC, Minter DW. 1988. *Tuber himalayense* sp. nov. with notes on Himalayan truffles. Transactions of the British Mycological Society 91:593–597.
- Zhang LF, Yang ZL, Song DS. 2005. A phylogenetic study of commercial Chinese truffles and their allies: taxonomic implications. FEMS Microbiology Letters 245: 85–92.

Studies on Croatian *Basidiomycota* 1: *Gerhardtia piperata* (Agaricales)

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Abstract — *Gerhardtia piperata* is recorded as new to Croatian mycobiota. Black and white photographs of fresh basidiomata and microscopic characters accompany a complete description. The genus *Gerhardtia* is reported from Croatia for the first time.

Key words — *Lyophyllaceae*, biodiversity, biogeography, taxonomy

Introduction

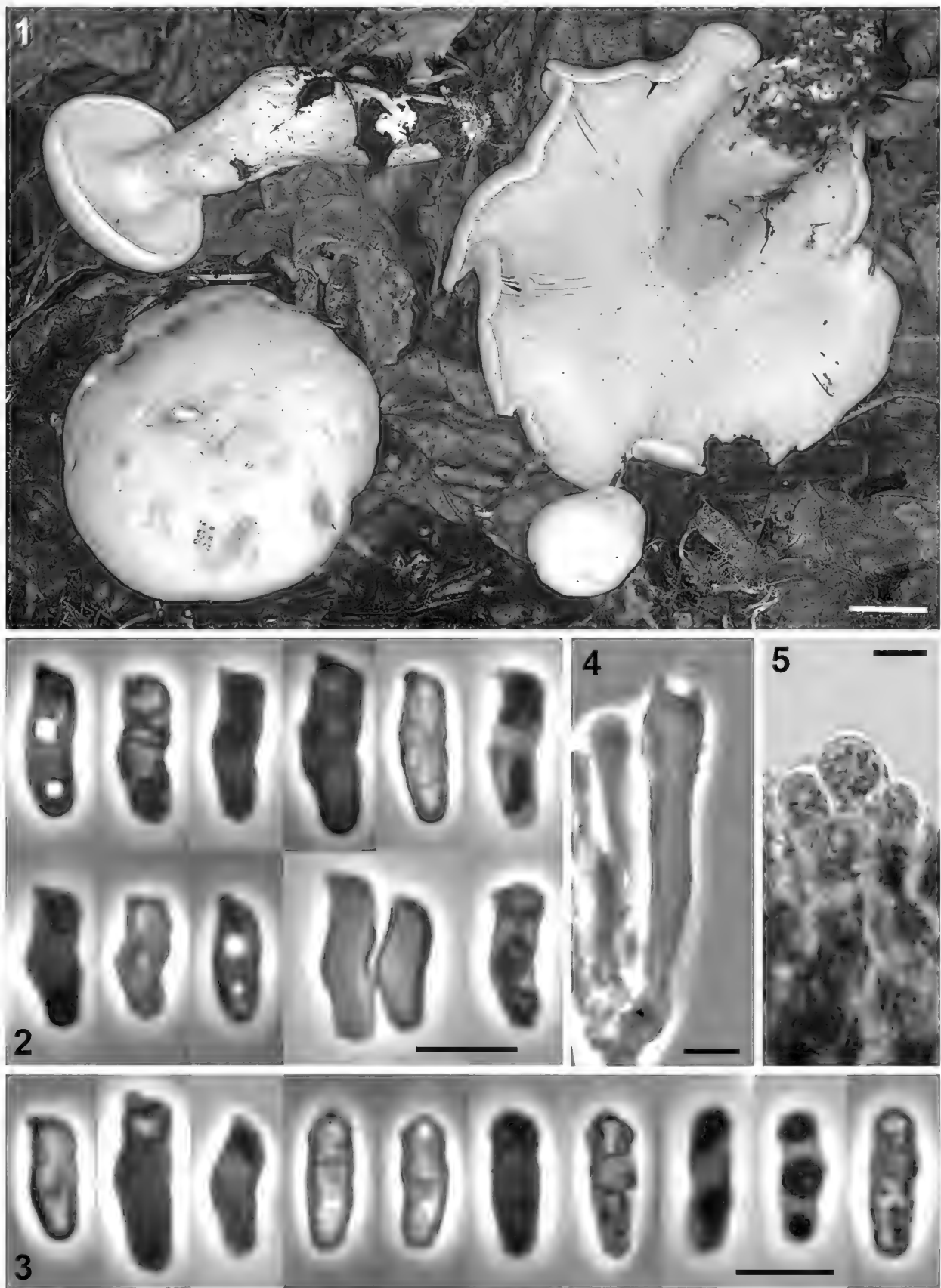
The Croatian Mycological Society, in cooperation with Ruđer Bošković Institute, has carried out the “Biodiversity of Croatian Fungi” project for ten years now (former name: Recording and Mapping of Croatian Fungi). The aim of the project is to determine which fungal species inhabit Croatia, their distribution, and their relation with the environment. As the first step of the project, surveys were made of all species recorded for Croatia representing the *Agaricales* (in the classical sense) up to 2000 (Mešić & Tkalčec 2002, 2003; Tkalčec & Mešić 2002, 2003a,b) and the gastroid *Basidiomycota* up to 2004 (Tkalčec et al. 2005b). The second phase involves intensive field research of Croatian mycobiota. The many valuable results achieved thus far include publication of three new species and a new variety (Hausknecht et al. 2007, Mešić & Tkalčec 2008, Tkalčec & Mešić 2008, Tkalčec et al. 2005a, 2009). Future significant results will be published in a series of scientific papers of which this is the first. This description of the rare species, *Gerhardtia piperata* (*Lyophyllaceae*, *Agaricales*), is the first record of a member of this genus in Croatia.

Gerhardtia piperata was described by A.H. Smith under the name *Clitocybe piperata* (Smith 1944). Harmaja (1974) transferred the species to *Rhodocybe* due to its undulate and cyanophilous spore wall, under the new name *Rhodocybe smithii*, because of the existence of the earlier similar name *R. piperita* (G. Stev.)

E. Horak. After that, Harmaja (1979) noticed siderophilous granulation in basidia of the holotype specimen and transferred the species to *Lyophyllum*, although *G. piperata* lacks clamp connections (unlike all other members of the genus). Gerhardt (1982) described a species of *Lyophyllum* without clamp connections, *L. incarnatobrunneum* Ew. Gerhardt, and placed it in the new subgenus *Lyophyllopsis* Ew. Gerhardt. Bon (1994) raised subgenus *Lyophyllopsis* to the generic level under the new name *Gerhardtia* Bon with two species included, *G. piperata* and *G. incarnatobrunnea* (Ew. Gerhardt) Bon (according to several authors this species is conspecific with *G. borealis* (Fr.) Contu & A. Ortega which name has priority, e.g. Contu & Ortega 2001, Kalamees 2008). Contu & Consiglio (2005) included four more species with uneven spore wall and no clamp connections in the genus, *G. highlandensis* (Hesler & A.H. Sm.) Cons. & Contu, *G. leucopaxilloides* (H.E. Bigelow & A.H. Sm.) Cons. & Contu, *G. marasmiioides* (Singer) Cons. & Contu, *G. suburens* (Clémenton) Cons. & Contu. Here we accept *Gerhardtia*, rather than submerging it in *Lyophyllum*. Phylogenetic analyses of the *Lyophyllaceae* (Hofstetter et al. 2002) based on nuclear and mitochondrial rDNA sequences showed that the generic concept of *Lyophyllum* based only on morphological characters (e.g. Singer 1986) is artificial and should be rearranged. Unfortunately, no species of *Gerhardtia* were included in the study.

Materials and methods

Our description of *Gerhardtia piperata* is based on Croatian records, six collections (consisting of 21 basidiomata) and two records without collected material. The photograph of basidiomata was taken in the field. The description of macroscopic characters is based on observations of fresh material. Color codes (given in brackets) are given according to Kornerup & Wanscher (1981). Specimens were preserved by drying. Microscopic features were observed with a light microscope (bright field and phase contrast) at magnifications up to 1500× and photographed with a digital camera. The morphological description and photographs of microscopic characters were made from rehydrated dried specimens mounted in 2.5% potassium hydroxide solution (KOH), except for spore analysis which was made in 10% ammonia solution (NH₄OH). Amyloidity and dextrinoidity were tested in Melzer's reagent, spore metachromasy in cresyl blue, spore cyanophily in cotton (aniline) blue, and basidium siderophilous granulation in acetocarmine following procedures detailed in Erb & Matheis (1983). Basidiospore measurements were calculated from calibrated digital photographs of spores taken from spore prints of two collections (CNF 1/2633, CNF 1/2677) in which 50 randomly selected spores per print (100 spores in total) were measured without the apiculus. In addition, 50 randomly selected spores were measured from the lamellae of one holotype basidioma. Spore measurements (length, width) are given as: (min.) stat. min.–av.–stat. max. (max.), where “min.” = minimum (lowest measured value), “stat. min.” = statistical minimum (arithmetic average minus two times standard deviation), “av.” = arithmetic average, “stat. max.” = statistical maximum (arithmetic average plus



FIGS. 1–5. *Gerhardtia piperata*. 1. Basidiomata in situ. 2–3. Spores (phase contrast). 4. Basidium (phase contrast). 5. Young basidia with siderophilous granulation. Bars: 1 = 20 mm, 2–5 = 5 µm.

two times standard deviation), “max.” = maximum (highest measured value). The range of arithmetic averages (av.) of spore measurements of each particular collection is also given. Standard deviation (SD) of spore length and width is given as: min.–total–max.,

where “min.” = collection with lower SD value, “total” = SD value of all 100 measured spores, and “max.” = collection with higher SD value. The length/width ratio of spores is given as the “Q” value (min.–av.–max.), and the range of arithmetic averages of “Q” value (Q av.) of each particular collection is also given. Croatian collections with accompanied data are deposited at the Croatian National Fungarium in Zagreb (CNF).

Taxonomic description

Gerhardtia piperata (A.H. Sm.) Bon, Doc. Mycol. 24(93): 67, 1994. FIGS 1–11

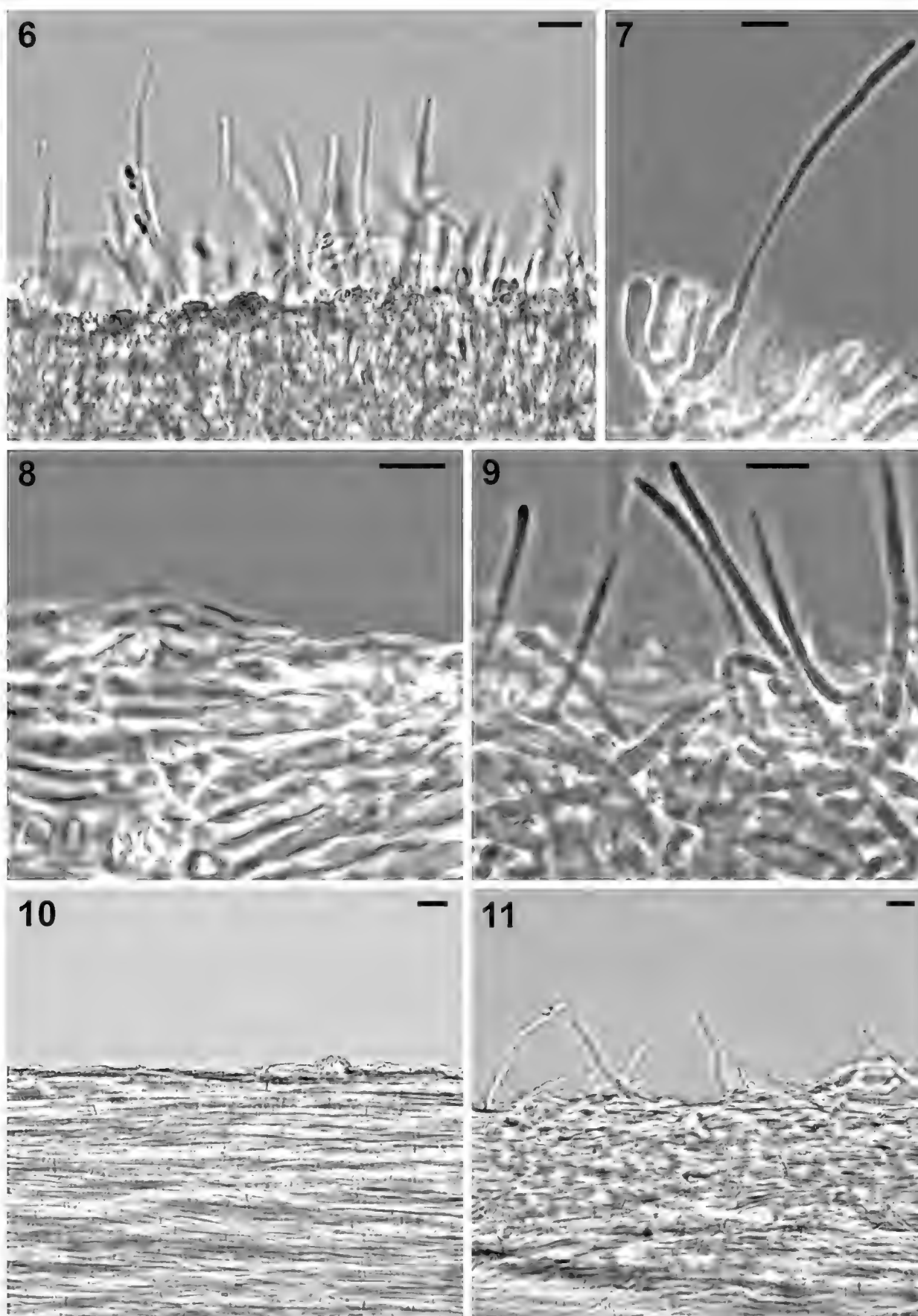
= *Clitocybe piperata* A.H. Sm., Bull. Torrey Bot. Club 71: 403, 1944. (basonym)

= *Rhodocybe smithii* Harmaja, Karstenia 14: 121, 1974.

= *Lyophyllum piperatum* (A.H. Sm.) Harmaja, Karstenia 19(1): 24, 1979.

PILEUS 56–120 mm broad, convex at first, expanding to plano-convex or applanate, sometimes wavy or somewhat lobed, margin involute to inflexed for a long time, not or hardly hygrophanous, not translucently striate, cream (3A2, 4A2) to dirty yellowish (3A3, 4A3), sometimes light brown when old, occasionally with darker watery spots, surface dry, dull, glabrous. **LAMELLAE** adnate to decurrent, crowded, narrow, often transvenose, sometimes furcate, cream, pale yellowish brown or brownish grey, with entire to undulate, concolorous edge. **STIPE** 47–103 × 13–30 mm, subcylindrical or tapering towards base, sometimes thickened in the middle, whitish to pale yellowish brown, surface glabrous, fibrillose to finely tomentose, sometimes with scattered minute scales, dry, solid. **CONTEXT** whitish to cream. **SMELL** fungoid with strong to weak flowery, perfume or fruity component when cut, often disagreeable. **TASTE** acrid after few seconds. **SPORE PRINT** yellowish cream (2A2).

SPORES (5.5–)5.3–6.6–7.8(–8.5) × (2.1–)2.0–2.4–2.8(–3.1) μm, av. 6.4–6.7 × 2.4–2.4 μm; SD = 0.51–0.62–0.71 × 0.20–0.20–0.20, Q = 2.26–2.72–3.11, Q av. = 2.67–2.77, subcylindrical to subfusiform in side view, often somewhat allantoid or flexuose, subcylindrical to cuneiform in frontal view, surface mostly ± undulate to nodose, without germ pore, hyaline, thin-walled, non-amyloid, non-dextrinoid, slightly to distinctly cyanophilous, some spores metachromatic (blue colored with light purple wall). **BASIDIA** (18–)25–34 × 5–7 μm, narrowly clavate, 4-spored, thin-walled, clampless, with siderophilous granulation. **LAMELLAREGE** fertile to heterogeneous. **CHEILOCYSTIDIA** absent, rare or locally abundant, 25–100 μm long, 1.8–3(–4) μm broad in upper part, 3–7 μm broad in basal part, (sub)cylindrical, filiform or narrowly lageniform (mostly with long, cylindrical neck), sometimes distorted under the angle or with subcapitate apex, at times with one or two septa, thin-walled, hyaline. **PLEUROCYSTIDIA** absent. **HYMENOPHORAL TRAMA** regular to subregular, composed of hyaline, thin-walled to moderately thick-walled (walls up to 0.8 μm thick), subcylindrical to inflated elements, 15–140 × 2–13(–18) μm. **PILEIPELLIS** a cutis with rare to abundant erect hyphae, in places dense erect hyphae forming a trichoderm,



FIGS. 6–11. *Gerhardtia piperata*. 6. Lamellar edge. 7. Cheilocystidium (phase contrast). 8. Pileipellis - cutis (phase contrast). 9. Pileipellis - trichoderm (phase contrast). 10. Stipitipellis - cutis. 11. Stipitipellis - cutis with erect hyphae. Bars = 10 μ m.

repent hyphae hyaline, thin-walled (walls up to 0.5 μm thick), cylindrical to inflated, 1.5–7(–12) μm broad, sometimes with lateral projections, erect hyphae (sub)cylindrical to filiform, hyaline, thin-walled, up to 140 μm long, 1.5–3(–4) μm broad. PILEAL TRAMA composed of hyaline, thin-walled to moderately thick-walled (walls up to 0.8 μm thick), subcylindrical to inflated, 2–20 μm broad elements. STIPITIPPELLIS similar to pileipellis, a cutis with very rare to abundant erect hyphae, in places dense erect hyphae forming a trichoderm, repent hyphae hyaline, thin-walled, cylindrical, 1.5–12 μm broad, sometimes with lateral projections, erect hyphae (sub)cylindrical to filiform, hyaline, thin-walled, up to 150 μm long, 2–3.5 μm broad. REFRACTIVE HYPHAE scattered in trama of whole basidioma. TRAMAL HYPHAE non-amyloid and non-dextrinoid. CLAMP CONNECTIONS absent.

HABITAT: Lowland forest of *Alnus glutinosa*, *Fraxinus angustifolia*, *Acer campestre*, *Corylus avellana*, *Staphylea pinnata*, *Sambucus nigra*, and *Salix* sp., on soil.

COLLECTIONS EXAMINED: CROATIA, vicinity of Novo Čiče village (near the town of Velika Gorica), 45°42'42"N, 16°06'54"E, alt. 103 m, leg. A. Mešić, Z. Tkalčec & M. Čerkez: 8 July 2002 (CNF 1/2633), 13 July 2002 (CNF 1/2639, 1/2643), 20 August 2002 (CNF 1/2677), 8 July 2009 (CNF 1/5565, 1/5566).

ADDITIONAL COLLECTION EXAMINED: USA, Michigan, Oakland County, Kent Lake, leg. A. H. Smith, 24 September 1940 (MICH 15462, holotype).

Discussion

Gerhardtia piperata is characterized by its tricholomatoid habit, large (≤ 120 mm broad) pileus, predominantly cream colored basidiomata, adnate to decurrent lamellae, almost immediately acrid taste, subcylindrical to subfusiform spores with undulate to nodose surfaces, siderophilous basidia, and absence of clamp connections. The most similar species is *G. suburens*, which differs mainly by a smaller (≤ 50 mm broad) pileus, taste that becomes sharp after ca. 30 seconds, distinct smell like *Lycoperdon* spp., and pileipellis that is a cutis lacking erect hyphae. Other species of the genus can be differentiated easily by a non-acrid taste.

According to our knowledge, *Gerhardtia piperata* hitherto has been found at seven localities in four countries: USA (Smith 1944), Germany (Bon 1979), France (Hertzog 1999, 2000; Wilhelm 2009), and Croatia. In USA, it was recorded five times at three different localities (Pontiac, Kent Lake, Dexter) in Michigan between 1937 and 1942 (from 31 July to 24 September) around or on old stumps and logs in low hardwood forests. The species was later found on 5 September 1975 northwest of Freiburg in southwestern Germany in an *Alnus-Fraxinus-Ulmus* flood forest. In France, *G. piperata* was found twice in Alsace province: near Ohnenheim on 24 September 1998 and in September 1999 in an

Alnus-Fraxinus-Populus-Ulmus flood forest and near Colmar on 12 September 2008 in a *Quercus-Carpinus betulus* dry forest. The distance between German and French localities is less than 30 km. In Croatia, it has been recorded eight times in 2002 and 2009 (from 8 July to 7 September) at one locality near Velika Gorica in the northwest part of the country in a lowland forest containing *Alnus glutinosa*, *Fraxinus angustifolia*, *Acer campestre*, *Corylus avellana*, *Staphylea pinnata*, *Sambucus nigra*, and *Salix* sp.

Although our observations correspond fairly well with the descriptions of *Gerhardtia piperata* in the literature, there are some differences:

- (i) The Smith (1944) protologue gives basidiospore dimensions as $4\text{--}5.5\text{--}6 \times 2\text{--}2.5\text{ }\mu\text{m}$, which is not in accordance with either other descriptions or observations from the holotype made by Bigelow (1965, 1985). Our spore measurements from the holotype agree exceptionally well with those from the Croatian material: $(5.3\text{--})5.3\text{--}6.4\text{--}7.4(8.6) \times (2.1\text{--})2.1\text{--}2.4\text{--}2.7(2.8)\text{ }\mu\text{m}$, $\text{SD} = 0.53 \times 0.16$, $Q = 2.16\text{--}2.65\text{--}3.19$.
- (ii) Smith's statement that clamp connections are rare contradicts all other observations of the species. Neither Bigelow nor our studies of the holotype confirmed the existence of clamp connections.
- (iii) Bon (1979), Contu & Consiglio (2005), and Hertzog (1999) described the spore print color as white; the color of two spore prints from Croatian material is yellowish cream.
- (iv) We note the existence of metachromatic spores in Croatian material and in the holotype that is not mentioned by other authors.
- (v) Basidiomata of *G. piperata* have similar cylindrical to filiform erect hyphae on the surface of the pileus and stipe, as well as on the lamellar edge, which are of different length and density. Smith (1944) used the term "projecting hairs" for erect hyphae on the pileus while Bigelow (1965, 1985) and Contu & Consiglio (2005) referred to them as "pilocystidia" and "pileocystidia", respectively. Bon (1979) and Hertzog (1999) described the pileipellis as a cutis with transitions to a trichoderm, and we share their opinion. Bon (1979), Contu & Consiglio (2005), and Smith (1944) stated that cheilocystidia were not present, while Bigelow (1965, 1985) and Hertzog (1999) did not mention cheilocystidia at all. Only Bon (1979) described erect hyphae on the lamellar edge projecting from the subhymenium or hymenophoral trama and called them marginal hyphae. For these elements we use the term cheilocystidia.

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Literature cited

- Bigelow HE. 1965. The genus *Clitocybe* in North America: Section *Clitocybe*. Lloydia 28: 139–180.
- Bigelow HE. 1985. North American Species of *Clitocybe*. Part II.. Beih. Nova Hedwigia 81: 281–471 + 204 figs.
- Bon M. 1979. Une nouvelle espece americaine pour la flore mycologique Europeenne: *Rhodocybe smithii* Harm. = *Clitocybe piperita* [sic] A.H. Smith. Doc. Mycol. 9(35): 23–25.
- Bon M. 1994. Deux *Lyophylloideae* interessantes et le genre *Gerhardtia* st. et nom. nov. Doc. Mycol. 24(93): 65–68.
- Contu M, Consiglio G. 2005 “2004”. Il genere *Gerhardtia* (*Lyophyllaceae*) in Europa, con osservazioni sulle rimanenti specie conosciute. Micol. Veg. Medit. 19(2): 151–162.
- Contu M, Ortega A. 2001. Studi sulle *Lyophyllaceae* della Sardegna. V. Morfologia sporale di *Rugosomyces pudicus* ed implicazioni sulla sua posizione sistematica. Bol. Soc. Micol Madrid 26: 171–176.
- Erb B, Matheis W. 1982. Pilzmikroskopie. Kosmos, Stuttgart.
- Gerhardt E. 1982. Über zwei neue Tricholomataceen: *Collybia hebelomoides* und *Lyophyllum incarnatobrunneum*, gefunden in Berlin. Z. Mykol 48(2): 239–243.
- Harmaja H. 1974. Notes on two agarics described in North America: 1. *Rhodocybe smithii* nom. nov., a new name for *Clitocybe piperata* A. H. Smith. 2. *Cystoderma adnatifolium* (Peck) n. comb., a species new for Europe. Karstenia 14: 121–122.
- Harmaja H. 1979. Type studies in *Clitocybe* 3. Karstenia 19: 22–24.
- Hausknecht A, Mešić A, Tkalčec Z. 2007. Two remarkable species of *Bolbitiaceae* (*Agaricales*) from Croatia. Österr. Z. Pilzk. 16: 281–286.
- Hertzog P. 1999. Une espèce rarissime, nouvelle pour la France, découverte dans le Ried d’Ohnenheim (67): *Gerhardtia piperata* (A. H. Smith) M. Bon. Bull. Soc. Mycol. Strasbourg 71: 19–20.
- Hertzog P. 2000. Récoltes intéressantes ou nouvelles du 2^{ème} semestre 1999. Bull. Soc. Mycol. Strasbourg 75: 13–15.
- Hofstetter V, Cléménçon H, Vilgalys R, Moncalvo J-M. 2002. Phylogenetic analyses of the *Lyophylleae* (*Agaricales*, *Basidiomycota*) based on nuclear and mitochondrial rDNA sequences. Mycol. Res. 106(9): 1043–1059.
- Kalamees K. 2008. *Gerhardtia* Bon. In: Funga Nordica. Agaricoid, boletoid and cyphelloid genera (eds. Knudsen H, Vesterholt J) Nordsvamp, Denmark: 496–497.
- Kornerup A, Wanscher JH. 1981. Taschenlexikon der Farben. Muster-Schmidt Verlag, Zürich - Göttingen.
- Mešić A, Tkalčec Z. 2002. Preliminary checklist of *Agaricales* from Croatia. II. Families *Agaricaceae*, *Amanitaceae*, *Cortinariaceae* and *Hygrophoraceae*. Mycotaxon 83: 453–502.
- Mešić A, Tkalčec Z. 2003. Preliminary checklist of *Agaricales* from Croatia IV: Families *Bolbitiaceae*, *Coprinaceae*, *Entolomataceae* and *Pluteaceae*. Mycotaxon 87: 283–309.
- Mešić A, Tkalčec Z. 2008. *Entoloma reinwaldii*, a rare species new to Croatia. Mycotaxon 105: 295–300.
- Singer R. 1986. The *Agaricales* in Modern Taxonomy. Koeltz Scientific Books, Koenigstein.
- Smith AH. 1944. Interesting North American agarics. Bull. Torrey Bot. Club 71(4): 390–409.

- Tkalčec Z, Mešić A. 2002. Preliminary checklist of *Agaricales* from Croatia. I. Families *Pleurotaceae* and *Tricholomataceae*. *Mycotaxon* 81: 113–176.
- Tkalčec Z, Mešić A. 2003a. Preliminary checklist of *Agaricales* from Croatia III: Families *Boletaceae*, *Gomphidiaceae* and *Paxillaceae*. *Mycotaxon* 87: 255–282.
- Tkalčec Z, Mešić A. 2003b. Preliminary checklist of *Agaricales* from Croatia V: Families *Crepidotaceae*, *Russulaceae* and *Strophariaceae*. *Mycotaxon* 88: 279–314.
- Tkalčec Z, Mešić A, Antonić O. 2005a. *Agaricales* (*Basidiomycota*, *Fungi*) of Sjeverni Velebit National Park in Croatia. *Period. Biol.* 107(3): 341–349.
- Tkalčec Z, Mešić A, Antonić O. 2005b. Survey of the gasteral *Basidiomycota* (*Fungi*) of Croatia. *Nat. Croatica* 14(2): 99–120.
- Tkalčec Z, Mešić A, Hausknecht A. 2009. Two new taxa of *Bolbitiaceae* from Croatia. *Mycotaxon* 107: 249–258.
- Wilhelm M. 2009. *Gerhardtia piperata*. http://www.pilze-basel.ch/Pilzbilder/Gerhardtia_piperata.pdf. Downloaded 3 June 2009.

A review of *Amauroderma* in Brazil, with *A. oblongisporum* newly recorded from the neotropics

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Abstract — Twenty species of *Amauroderma* are accepted from Brazil. *Amauroderma oblongisporum* is for the first time recorded for the neotropics and is described and illustrated. It is characterized by oblong ellipsoid, hyaline to pale yellowish basidiospores, with slightly protruding endosporic projections. A checklist and key to the Brazilian species of *Amauroderma* are presented.

Key words — *Basidiomycota*, *Ganodermataceae*, taxonomy

Introduction

Since Murrill (1905) proposed the genus *Amauroderma* (*Ganodermataceae*, *Polyporales*), their species have been studied primarily by Ryvar den & Johansen (1980), Furtado (1981), Corner (1983), and Moncalvo & Ryvar den (1997), who have made major contributions to the nomenclature and taxonomy of the genus.

Amauroderma is a widespread tropical genus with around 30 species (Kirk et al. 2008) that usually occurs on roots of living or dead trees (sometimes appearing as if emerged from the soil) or, more rarely, wood inhabiting (Furtado 1981, Ryvar den 2004a,b) and causes a white rot. The genus is distinguished by round to oblong ellipsoid double-walled basidiospores with a smooth exosporium and a columnar endosporium (Nuñez & Ryvar den 2000, Ryvar den 2004b); basidiomata are stipitate and generally brown in most species but sessile, dimidiate, and wood-inhabiting in *A. africana* Ryvar den and *A. andina* Ryvar den (Ryvar den 2004a). The structure of the pilear cover is also considered taxonomically significant in the genus (Furtado 1981).

During a survey of *Ganodermataceae* in the Atlantic Rain Forest of São Paulo State, Southeast Brazil, we found an *Amauroderma* specimen deposited in the herbarium SP with oblong ellipsoid, hyaline to pale yellowish basidiospores with slightly protruding endosporic projections. Of the 21 *Amauroderma* species registered from the neotropics (Ryvar den 2004b), none exhibited

the characters above. After checking the literature on *Ganodermataceae*, we identified the species as *A. oblongisporum*.

The aim of this study is to review the knowledge of the genus *Amauroderma* (*Ganodermataceae*) from Brazil.

Materials and methods

The specimen was collected in a remnant of the Atlantic Rain Forest in the Parque Estadual das Fontes do Ipiranga (23°38'00"–23°40'18"S and 46°36'48"–46°38'08"W, 549.31 ha), municipality of São Paulo, São Paulo State, Brazil (Bicudo et al. 2002), and was deposited in SP herbarium (Holmgren & Holmgren 1998).

The material was examined following Ryvarden (1991, 2004b). Micromorphological observations were made from material mounted in 5% KOH and Melzer's reagent; measurements were made in 5% KOH through LAS ES Version 1.4.0. software in a Leica DM 1000 microscope.

Literature on *Ganodermataceae* was also consulted in generate a list of *Amauroderma* species previously recorded from Brazil.

Taxonomy

New to the neotropics

Twenty species of *Amauroderma* are accepted from Brazil. *Amauroderma oblongisporum*, a new record for the neotropics, is distinguished by its oblong ellipsoid, hyaline to pale yellowish basidiospores with slightly protruding endosporic projections.

Amauroderma oblongisporum J.S. Furtado, Revis. Gên. *Amauroderma*:

208, 1968.

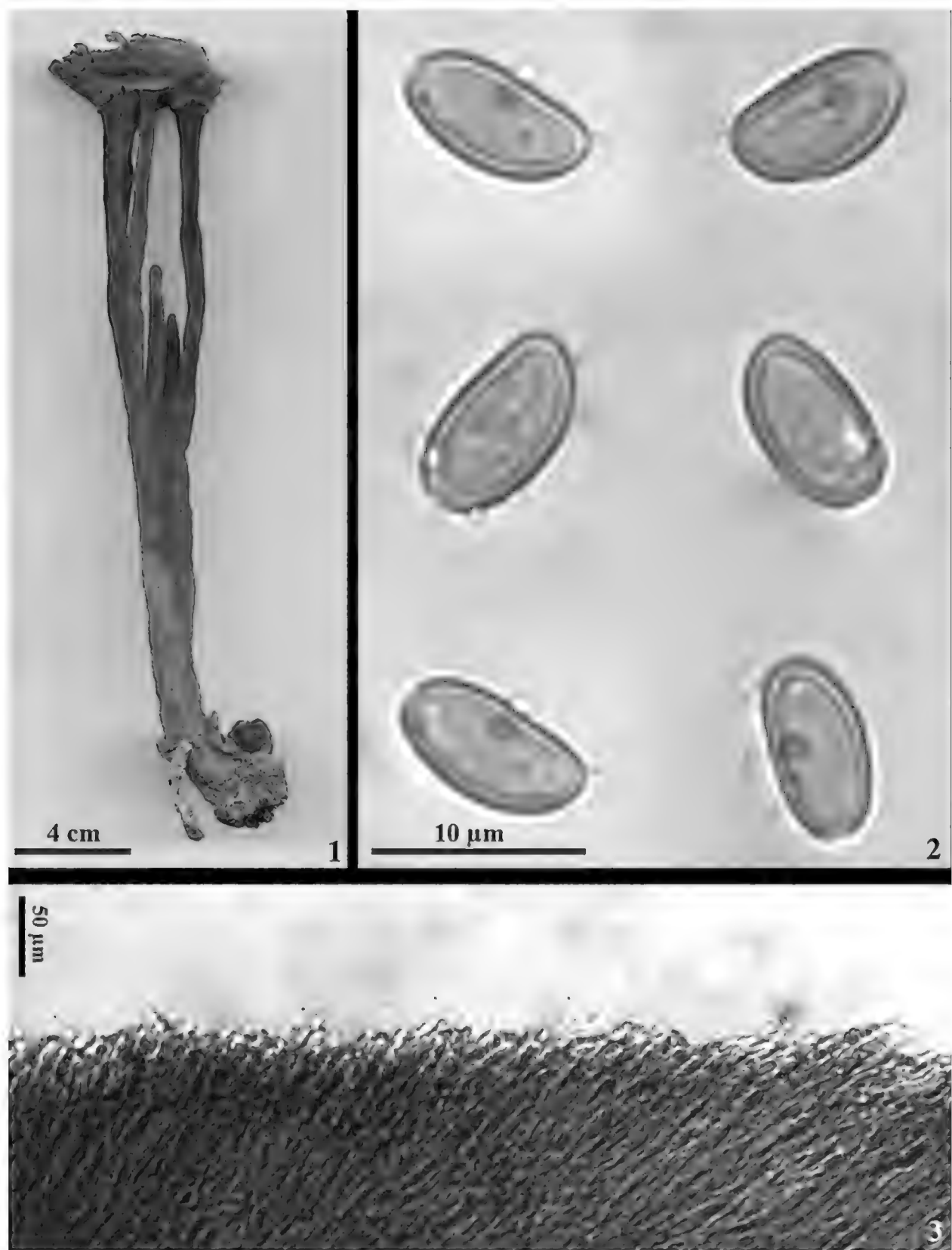
Figs. 1–3

≡ *Polyporus fuscatus* Lloyd, Mycol. Writ. 6: 942. 1920, nom.

illegit., non *Polyporus fuscatus* Fr. 1818.

≡ *Amauroderma fuscatum* Otieno, Sydowia 22: 175, 1969, nom. nov. superfl.

BASIDIOMA annual, stipitate, single mesopodal to pseudomesopodal with several pilei from a common stipe, woody to sub-woody, convex when small to concave when well developed. **PILEUS** circular, margin inflexed when dry, 3–4 cm diam, up to 0.7 cm thick; abhymenial surface pale brown to deep brown, dull, concentrically zoned, glabrous. **CONTEXT** homogeneous, concolorous to slightly paler than the upper surface, 0.4 cm thick. **HYMENIAL SURFACE** poroid, concolorous with the context, pores round, 4–5/mm; tubes concolorous, up to 3 mm deep. **STIPE** central, deep brown, single or branched, 6.5–13.5 × 0.3–0.6 cm, swollen at the base where the stipes are fused. **PILEAR COVER** a cortex with slight incrustation. **HYPHAL SYSTEM** trimitic; generative hyphae with clamps, hyaline, thin-walled, 3.75–6.25 µm diam; skeletal hyphae arboriform to



FIGS. 1-3. *Amauroderma oblongisporum*. 1. Basidiomata, 2. Basidiospores, 3. Pilear cover.

aciculiform, subhyaline to pale yellowish, thick-walled, 5–12.5 µm diam, up to 1.25–3.75 µm diam in the apices; binding hyphae much branched, subhyaline to pale yellowish, thick-walled to almost solid, 2.5–5 µm diam. BASIDIA not seen. BASIDIOSPORES oblong ellipsoid, hyaline to pale yellowish with slightly

protruding endosporic projections, $10\text{--}12.5 \times 6.25\text{--}7.5 \mu\text{m}$, negative in Melzer's reagent.

MATERIAL EXAMINED: BRAZIL. SÃO PAULO STATE: São Paulo, Parque Estadual das Fontes do Ipiranga, 2.I.1970, B. Skvortzov s.n. (SP 107239).

DISTRIBUTION: previously known only from tropical Africa (Furtado 1981, Ryvar den & Johansen 1980, Moncalvo & Ryvar den 1997).

REMARKS: *Amauroderma oblongisporum* may be recognized by its basidiomata with several pilei originating from a common stipe, a feature also described by Ryvar den & Johansen (1980). However these authors reported smaller (5–8 per mm) pores, while the examined material has 4–5 pores per mm, as also described by Furtado (1981). The species is microscopically distinguished by oblong ellipsoid basidiospores, up to $13 \mu\text{m}$ long and $8 \mu\text{m}$ wide and with slightly protruding endosporic projections (Furtado 1981, Ryvar den & Johansen 1981). The cystidioles reported by Ryvar den & Johansen (1981) were not observed.

Amauroderma elegantissimum, which also occurs in Brazil, produces a similar basidioma with thin stipe and ellipsoid, thin-walled, very finely ornamented basidiospores (Ryvar den 2004b). It is distinguished from *A. oblongisporum* by larger ($12\text{--}15 \times 8\text{--}10 \mu\text{m}$) basidiospores, slightly smaller (5–7/mm) pores, and tramal tissues containing dark-brown, short, setae-like skeletal hyphae with rounded to pointed apices, some with a few lateral $3\text{--}12 \times <180 \mu\text{m}$ protuberances or outgrowths (Ryvar den 2004b).

Moncalvo & Ryvar den (1997), who stated that *A. oblongisporum* is a superfluous name, cited *A. fuscatum* as the correct name for the species. However, as both represent new names proposed for the illegitimate *Polyporus fuscatus* Lloyd, the earlier name (*A. oblongisporum* Furtado 1968) is correct and the later *A. fuscatum* (Otieno 1969) is superfluous.

***Amauroderma* species previously recorded in Brazil**

Amauroderma aurantiacum (Torrend) Gibertoni & Bernicchia,

Mycotaxon 104: 322. 2008.

For synonymy, see Gibertoni et al. (2008).

DESCRIPTION: Furtado (1981), Ryvar den (2004b), as *A. macrosporum* J.S. Furtado.

DISTRIBUTION: Brazil and Venezuela (Ryvar den 2004b). In Brazil cited from Goiás (type locality), Rondônia, Sergipe, São Paulo (type locality of *A. macrosporum*, Bononi et al. 1981, Furtado 1981, Ryvar den 2004b, Gibertoni et al. 2004, 2007, 2008).

REMARKS: Meijer (2006) reported the occurrence of *Amauroderma* cf. *macrosporum* in Paraná State. Previous records of *A. macrosporum* from Sergipe State (Gibertoni et al. 2004) and from Pará State (Sotão et al. 1997, 2002) were re-identified as *A. calcigenum* and *A. schomburgkii*, respectively by Gibertoni et al. (2008).

Amauroderma boleticeum (Pat. & Gaillard) Torrend,
Broteria, ser. Bot. 18: 132, 1920.

DESCRIPTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: known from southern Brazil to Venezuela and Colombia (Ryvarden 2004b). In Brazil cited from Pará, Bahia, Mato Grosso (Furtado 1981, Góes-Neto 1999).

Amauroderma brasiliense (Singer) Ryvarden, Syn. Fung. (Oslo) 19: 44, 2004.
For synonymy, see Coelho et al. (2007).

DESCRIPTION: Ryvarden (2004b), Coelho et al. (2007).

DISTRIBUTION: Brazil and Venezuela (Ryvarden 2004b). In Brazil cited from Amazonas (type locality of *A. brasiliense*), Rondônia, São Paulo (type locality of syn. *A. corneri* Gulaid & Ryvarden), Paraná, Santa Catarina, Rio Grande do Sul States (Singer et al. 1983, Gulaid & Ryvarden 1998, Ryvarden & Meijer 2002, Groposo & Loguercio-Leite 2005, Meijer 2006, Coelho et al. 2007).

Amauroderma calcigenum (Berk.) Torrend, Broteria, ser. bot. 18: 129, 1920.
For synonymy, see Furtado (1981), Ryvarden (1984).

DESCRIPTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: Southern Brazil to Venezuela and Guyana; probably widespread throughout the Amazonian basin (Ryvarden 2004b). In Brazil cited from Amazonas (type locality of syns. *Polyporus partitus* Berk. and *Hexagonia gracilis* Berk.), Sergipe, Bahia (type locality of syn. *P. torrendii* Lloyd), Goiás (type locality of *A. calcigenum*), Mato Grosso, Rio de Janeiro, São Paulo, Santa Catarina, Rio Grande do Sul (Torrend 1920, Rick, 1960, Furtado 1981, Corner 1983, Ryvarden 1984, Góes-Neto 1999, Gibertoni et al. 2008).

Amauroderma camerarium (Berk.) J.S. Furtado,
Revis. Gên. *Amauroderma*: 140, 1968.

For synonymy, see Furtado (1981), Ryvarden (1984).

DESCRIPTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: Southern Brazil, Cuba, Belize, Venezuela, Peru, Honduras, Colombia (Furtado 1981, Ryvarden 2004b). In Brazil cited from Amazonas (type locality of *A. camerarium* and syns. *Polyporus pallidus* Berk., *P. variabilis* Berk., *P. polydactylus* Berk.), Bahia, Mato Grosso, Pernambuco, Rio de Janeiro, Rio Grande do Sul (type locality of syn. *P. inopinus* Lloyd), Paraná, Santa Catarina (Torrend 1920, Batista 1949, Maia 1960 as *A. trulliforme* (Lloyd) Torrend, Rick 1960, Furtado 1981, Ryvarden 1984, Rajchenberg & Meijer 1990, Silveira & Guerrero 1991, Groposo & Loguercio-Leite 2005, Góes-Neto 1999, Maia et al. 2002, Ryvarden & Meijer 2002). Meijer (2006) also reported *Amauroderma* cf. *camerarium* for Paraná State.

Amauroderma coltricioides T.W. Henkel, Aime & Ryvarden,
Mycologia 95(4): 615, 2003.

DESCRIPTION: Ryvarden (2004b).

DISTRIBUTION: Guyana (type locality) and Brazil (Rio Grande do Sul; see Silveira et al. 2008).

Amauroderma elegantissimum Ryvarden & Iturr.,

Syn. Fung. (Oslo) 19: 54, 2004.

DESCRIPTION: Ryvarden (2004b).

DISTRIBUTION: Venezuela (type locality), Brazil (Roraima state), Guyana (Ryvarden 2004b).

Amauroderma exile (Berk.) Torrend, Broteria, ser. bot. 18: 142, 1920.

For synonymy, see Furtado (1981), Ryvarden (1984).

DESCRIPTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: Indonesia, China, and tropical America (Zhao 1989, Moncalvo & Ryvarden 1997), where it is probably widespread in the Amazonian basin and known southern Brazil to Venezuela and Colombia and (Ryvarden 2004b). In Brazil cited from Amazonas (type locality of *Polyporus exilis* Berk. and syns. *P. renatus* Berk., *P. marasmiioides* Berk., *P. parmula* Berk., *P. macer* Berk., *P. passerinus* Berk., *P. procerus* Berk.), Pernambuco, Bahia, Rio de Janeiro, Rio Grande do Sul (Hennings 1904b, Torrend 1920 & 1938, Rick 1960, Furtado 1981, Corner 1983, Ryvarden 1984, Góes-Neto 1999, Maia et al. 2002).

Amauroderma fasciculatum (Pat.) Torrend, Broteria, ser. bot. 18: 139, 1920.

For synonymy, see Furtado (1981).

DESCRIPTION: Ryvarden & Johansen (1980), Furtado (1981).

DISTRIBUTION: Africa (Furtado 1981, Ryvarden & Johansen 1980) and Brazil, where it is cited from Acre (Bononi 1992) and Pernambuco (Góes-Neto & Baseia 2006).

REMARKS: Maia (1960) reported the occurrence of the synonymous *A. trulliforme* in Bahia State, but the specimen was examined later by Furtado (1981, whom we follow) and re-identified as *A. camerarium*.

Amauroderma omphalodes (Berk.) Torrend, Broteria, ser. bot. 18: 131, 1920.

For synonymy, see Furtado (1981).

DESCRIPTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: Southern Brazil to Venezuela and Colombia; probably widespread in the Amazonian basin (Ryvarden 2004b). In Brazil cited from Amazonas (type locality of *Polyporus omphalodes* Berk. and syn. *P. pansus* Berk.), Sergipe, Alagoas, Pernambuco, Bahia, Mato Grosso, Rio de Janeiro, Paraná, Santa Catarina (Hennings 1900, 1904b, Torrend 1920, Furtado 1981, Ryvarden 1984, Loguercio-Leite & Wright 1991, Góes-Neto 1999, Maia et al. 2002, Ryvarden & Meijer 2002, Gibertoni & Cavalcanti 2003, Góes-Neto et al. 2003, Gibertoni et al. 2004, 2007, Góes-Neto & Baseia 2006, Drechsler-Santos et al. 2008).

Amauroderma praetervisum (Pat.) Torrend, Broteria, ser. bot. 18: 131, 1920.

For synonymy, see Furtado (1981).

DESCRIPTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: Southern Brazil, Belize, Costa Rica, and Mexico (Ryvarden 2004b). In Brazil cited from Pará, Paraíba, Pernambuco, Bahia, Rio de Janeiro (type locality of syn. *Fomes auriscalpioides* Henn.), Mato Grosso, Paraná (Hennings 1904a, Torrend 1920, Batista 1949, Furtado 1981, Góes-Neto 1999, Maia et al. 2002, Gibertoni et al.

2004, 2007). Meijer (2006) reported the occurrence of *Amauroderma* cf. *praetervisum* in Paraná State.

***Amauroderma pseudoboletus* (Speg.) J.S. Furtado,**

Revis. Gên. *Amauroderma*: 230, 1968.

DESCRIPTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: Southern Brazil to Venezuela and Colombia and probably widespread in the Amazonian basin (Ryvarden 2004b). In Brazil cited from Rio de Janeiro, São Paulo, Paraná, Rio Grande do Sul (Bononi et al. 1981, Furtado 1981, Ryvarden & Meijer 2002). Meijer (2006) reported the occurrence of *Amauroderma* cf. *pseudoboletus* in Paraná State.

REMARKS: *Amauroderma pseudoboletus* is treated as a synonym of *A. rude* in the CABI (<<http://www.indexfungorum.org>>) and CBS *Aphylllophorales* (<<http://www.cbs.knaw.nl>>) databases. However, Furtado (1981) and Ryvarden (2004b) differentiate *A. pseudoboletus* with a cortex-like pileipellis and larger (12–13 × 9–11 µm) basidiospores from *A. rude* with a derm-like pileipellis and smaller (9–11 × 7.5–9 µm) basidiospores. We also consider *A. pseudoboletus* an independent taxon

***Amauroderma renidens* (Bres.) Torrend, Broteria, ser. bot. 18: 136, 1920.**

DESCRIPTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: Brazil [Santa Catarina (type locality), Mato Grosso do Sul, Bahia States; see Torrend 1920, Furtado 1981, Góes-Neto 1999, Ryvarden 2004b, Bononi et al. 2008).

***Amauroderma rude* (Berk.) Torrend, Broteria, ser. bot. 18: 127, 1920.**

DESCRIPTION: Furtado (1981), Ryvarden (2004b as *A. intermedium* (Bres. & Pat.) Torrend).

DISTRIBUTION: China, Australia, Africa (Zhao 1989), tropical America (from Paraguay to Puerto Rico; cf. Ryvarden 2004b). In Brazil cited from Amazonas, Pernambuco, Bahia, Rio de Janeiro, São Paulo, Paraná, Santa Catarina (Torrend 1920, Batista 1949, Bononi et al. 1981, Furtado 1981, Góes-Neto 1999, Maia et al. 2002, Ryvarden & Meijer 2002).

REMARKS: Furtado (1981) considers *Amauroderma intermedium* a variety of *A. rude* based on microscopical similarities and intergrading macroscopic characters. Ryvarden (2004b), however, considers *A. intermedium* an independent taxon. The CABI (<<http://www.indexfungorum.org>>) and CBS *Aphylllophorales* (<<http://www.cbs.knaw.nl>>) databases list *A. intermedium* as a synonym of *A. rude*.

***Amauroderma schomburgkii* (Mont. & Berk.) Torrend,**

Broteria, ser. bot. 18: 140, 1920.

For synonymy, see Furtado (1981), Ryvarden (1984).

DESCRIPTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: Southern Brazil to Cuba, Puerto Rico, Jamaica and (seemingly) the most common, locally abundant neotropical *Amauroderma* species (Ryvarden 2004b).

In Brazil cited from Amazonas (type locality of syns. *Polyporus brunneopictus* Berk., *P. cassicolor* Berk., *P. ocellatus* Berk., *P. xylodes* Berk.), Rondônia, Pará, Sergipe, Pernambuco, Bahia (type locality of syns. *P. papillatus* Lloyd, *A. gusmanianum* Torrend, *A. mosselmanii* Torrend), Mato Grosso, Rio de Janeiro, São Paulo, Paraná and Rio Grande do Sul (Torrend 1920, 1938, Batista 1949, Bononi et al. 1981, Furtado 1981, Corner 1983, Ryvarden 1984, Capelari & Maziero 1988, Rajchenberg & Meijer 1990, Góes-Neto 1999, Maia et al. 2002, Ryvarden & Meijer 2002, Sotão et al. 2002, Gibertoni et al. 2004, 2007, 2008, Meijer 2006).

***Amauroderma sprucei* (Pat.) Torrend, Broteria, ser. bot. 18: 125, 1920.**

For synonymy, see Furtado (1981), Ryvarden (1984).

DESCRIPTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: Southern Brazil to Belize, Cuba, Colombia, Puerto Rico, and Jamaica (Ryvarden 2004b, Decock & Herrera Figueroa 2006). In Brazil cited from Amazonas (type locality of syn. *Porothelium rugosum* Berk.), Pará, Sergipe, Pernambuco, Mato Grosso, Minas Gerais (type locality of syn. *Polyporus dubiopansus* Lloyd), Rio de Janeiro, São Paulo (type locality of syn. *Fomes paulensis* Henn.), Paraná, Rio Grande do Sul (Hennings 1904c, Torrend 1920, Rick 1960, Bononi et al. 1981, Furtado 1981, Corner 1983, Ryvarden 1984, 1990, Rajchenberg & Meijer 1990, Ryvarden & Meijer 2002, Sotão et al. 2002, Gibertoni et al. 2004, 2007).

***Amauroderma subrugosum* (Bres. & Pat.) Torrend,
Broteria, ser. bot. 18: 128, 1920.**

DESCRIPTION: Furtado (1981).

DISTRIBUTION: Throughout the tropics, including southern China and Japan (Moncalvo & Ryvarden 1997). In Brazil cited from Pará (Sotão et al. 1997, 2002).

***Amauroderma trichodematum* J.S. Furtado,
Revis. Gên. *Amauroderma*: 311, 1968.**

DISTRIBUTION: Furtado (1981), Ryvarden (2004b).

DISTRIBUTION: Venezuela and Brazil. In Brazil cited from Pará (type locality) and Paraná (Furtado 1981, Ryvarden & Meijer 2002, Ryvarden 2004b, Meijer 2006).

***Amauroderma unilaterum* (Lloyd) Ryvarden, Mycotaxon 38: 101, 1990.**

DESCRIPTION: Ryvarden (2004b).

DISTRIBUTION: known only from Amazonas (the type locality) and Bahia states, Brazil (Torrend 1920, Góes-Neto 1999, Ryvarden 1990, 2004b).

Species excluded from *Amauroderma*

Some *Amauroderma* species reported from Brazil belong in other genera. Most authors (Furtado 1967, 1981, Ryvarden 1984, 1990, Moncalvo & Ryvarden 1997) consider *A. angustum* (Berk.) Torrend (1920) and *A. infulgens* (Lloyd) Torrend (1920) synonyms of *Humphreya coffeata* (Berk.) Steyaert.

Amauroderma longipes (Lév.) Torrend (1920) is now accepted as *Haddowia longipes* (Lév.) Steyaert (Steyaert 1972, Moncalvo & Ryvarden 1997, Ryvarden 2004b).

Amauroderma brittonii Murrill (Sotão et al. 1991, 2003) is a synonym of *Laetiporus persicinus* (Berk. & M.A. Curtis) Gilb. (Ryvarden 1985, Moncalvo & Ryvarden 1997).

“*Amauroderma fractipes*” reported from Bahia by Góes-Neto (1999) probably is an error for *Abortiporus fractipes* (Berk. & M.A. Curtis) Gilb. & Ryvarden.

Insufficiently known taxa and dubious names

Amauroderma auriscalpium (Pers.) Torrend, Broteria, ser. bot. 18: 131, 1920.

The taxonomic status of *A. auriscalpium* is doubtful and needs further research. This species, described from Brazil (Rio de Janeiro state), has also been reported from Bahia (Torrend 1920, Góes-Neto 1999), Rio Grande do Sul (Rick 1960), and Pernambuco (Batista 1949, Maia et al. 2002). Rick (1938), who reported *A. auriscalpium* from Rio Grande do Sul, separated it in three varieties (var. *omphalodes*, var. *praetervisum*, var. *subrenatus*). Furtado (1981) treats these as three independent species: *A. omphalodes*, *A. praetervisum*, and *A. camerarium*, respectively. After examining other specimens that Torrend and Rick identified as *A. auriscalpium*, Furtado (1981) referred Torrend's identification to *A. schomburgkii* and Rick's to *A. camerarium*. Batista (1949) and Maia et al. (2002), who cite *A. auriscalpium* from Pernambuco state, did not publish description or specimen data.

Amauroderma fuscoporia Wakef., Bothalia 4(4): 948, 1948.

Ryvarden & Johansen (1980) and Moncalvo & Ryvarden (1997) cite this species only from the type locality (Zimbabwe, Africa), and neither Furtado (1981) nor Ryvarden (2004b) cite material from Brazil. Sotão et al. (2002), who first cited *A. fuscoporia* from Pará state, did not later repeat that observation (Sotão et al. 2008). The species' presence in Brazil remains doubtful and deserves further research.

Amauroderma juruense (Henn.) Torrend, Broteria, ser. bot. 18: 142, 1920.

The species has been collected only once, from the type locality in Amazonas State, Brazil. Furtado (1981), who was unable to locate the type specimen, noted its similarity to the type of *Polyporus ocellatus* (synonym of *A. schomburgkii*). According to Moncalvo & Ryvarden (1997), no authentic specimen has been preserved and this name should be abandoned. *Amauroderma juruense* is considered a dubious name in the CBS database (<<http://www.cbs.knaw.nl>>).

Amauroderma nigrum sensu Rick, Iheringia, sér. bot. 7: 211, 1960, nom. inval.

This species was reported from Rio Grande do Sul State, Brazil, by Rick (1960). According to Furtado (1981) and CABI database (<<http://www.indexfungorum.org>>), *A. nigrum* is a synonym of *A. subrugosum*. However, Zhao (1989), who examined the types of *A. nigrum* and *A. subrugosum*, concluded that they represent two distinct species. Moncalvo & Ryvarden (1997) stated

that the taxonomic status of this species needs further re-evaluation, a view we endorse. Furtado (1981), who did not find any material from the neotropics, questioned the occurrence of *A. nigrum* in Brazil and Ryvarden (2004b) also does not cite the species from neotropical regions. Rajchenberg (1987) did not treat it in his study of Rick's polypore types.

Amauroderma picipes Torrend, Broteria, ser. bot. 18: 132, 1920.

The species is known only from the type locality in Bahia state, Brazil, and no modern description has been found in the literature. Neither Furtado (1981) nor Ryvarden (2004b) cite *A. picipes* for the region. According to Moncalvo & Ryvarden (1997) no authentic specimen has been preserved and this name should be abandoned.

Key to *Amauroderma* species in Brazil

- 1. Pores 1–3 per mm 2
- 1. Pores 3–9 per mm 7
- 2. Abhymenial surface laccate *A. renidens*
- 2. Abhymenial surface dull to slightly glittery (but not with laccate appearance) 3
- 3. Basidiome fragile when dry, gloeopleurous hyphae
 present in the context and trama *A. brasiliense*
- 3. Basidiome coriaceous to woody when dry, gloeopleurous hyphae absent 4
- 4. Abhymenial surface with black glabrous zones alternating with dark-brown
 tomentose zones covered with hair-like elements
 giving a hirsute appearance *A. trichodermium*
- 4. Abhymenial surface glabrous to finely velutinous 5
- 5. Pilear cover as a derm, basidiospores 9–11 × 7.5–9 µm *A. rude*
- 5. Pilear cover as a cortex, basidiospores 12–16 µm in longest dimension 6
- 6. Basidiospores broadly ellipsoid, 12–15 × 9–12 µm *A. calcigenum*
- 6. Basidiospores subglobose to globose, 13–16 × 13–15 µm *A. aurantiacum*
- 7. Basidiospores up to 10 µm diam 8
- 7. Basidiospores 10–17 µm long 13
- 8. Pores 7–8 per mm, basidiospores smooth *A. coltricioides*
- 8. Pores 3–7 per mm, basidiospores ornamented 9
- 9. Pores 3–4 per mm *A. boleticeum*
- 9. Pores 5–7 per mm 10
- 10. Pilear cover a derm 11
- 10. Pilear cover a cortex 12
- 11. Context white to cream, pileus reddish brown *A. sprucei*
- 11. Context yellowish-brown near cinnamon to gold-brown, pileus
 blackish-brown, blackish-gray, or darker, close to black *A. subrugosum*

12. Pileus flexible, abhymenial surface glittery (but not laccate),
skeletal hyphae strongly dextrinoid *A. exile*
12. Pileus coriaceous to woody, abhymenial
surface dull, skeletal hyphae not dextrinoid *A. schomburgkii*
13. Basidiospores ellipsoid 14
13. Basidiospores globose to subglobose 16
14. Basidiospores distinctly ornamented, wider than 10 µm *A. camerarium*
14. Basidiospores with a very fine ornamentation, almost invisible even at
1000× magnification, 6–10 µm wide 15
15. Pores 4–5 per mm, basidiospores 10–12.5 × 6.25–7.5 µm *A. oblongisporum*
15. Pores 5–7 per mm, basidiospores 12–15(–16) × 8–10 µm *A. elegantissimum*
16. Context with two black resinous bands 17
16. Context homogeneous without black bands 18
17. Context yellowish to cinnamon, basidiospores yellowish with conspicuous
endosporic projections, 11–14 × 10–13 µm *A. omphalodes*
17. Context white, becoming yellowish brown, basidiospores hyaline to subhyaline,
with few distinct endosporic projections,
10–13(–14) × (9–)10–12 µm *A. praetervisum*
18. Pileus blackish-gray to almost black, basidiospores
15–17 × 13–15 µm *A. unilaterum*
18. Pileus dark reddish brown, basidiospores up to 15 µm long 19
19. Pilear cover a cortex, pores 3–5 per mm *A. pseudoboletus*
19. Pilear cover a derm, pores 5–9 per mm 20
20. Pores 5–8 per mm, basidiospores with few conspicuous endosporic projections,
(7.5–)9–11 × (6–)8–10 µm *A. subrugosum*
20. Pores 6–9 per mm, basidiospores with very conspicuous endosporic projections,
which give a verrucose appearance to the spore wall,
12–15 × 10–13 µm *A. fasciculatum*

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Literature cited

- Batista AC. 1949. Espécies de *Amauroderma* do Jardim Zoo-Botânico do Recife. Boletim da Secretaria de Agricultura, Indústria e Comércio 16: 125.
- Bicudo DC, Forti MC, Bicudo CEM. 2002. Parque Estadual das Fontes do Ipiranga (PEFI): unidade de conservação que resiste à urbanização de São Paulo. São Paulo: Secretaria do Meio Ambiente do Estado de São Paulo. 351 pp.

- Bononi VLR, Oliveira AKM, Quevedo JR, Gugliotta AM. 2008. Fungos macroscópicos do Pantanal do Rio Negro, Mato Grosso do Sul, Brasil. *Hoehnea* 35: 489–511.
- Bononi VLR, Trufem SFB, Grandi RAP. 1981. Fungos macroscópicos do Parque Estadual das Fontes do Ipiranga, São Paulo, Brasil, depositados no herbário do Instituto de Botânica. *Rickia* 9: 37–53.
- Bononi VLR. 1992. Fungos macroscópicos de Rio Branco, Acre, Brasil. *Hoehnea* 19: 31–37.
- Capelari M, Maziero R. 1988. Fungos macroscópicos do Estado de Rondônia, Região dos Rios Jaru e Ji-Paraná. *Hoehnea* 15: 28–36.
- Coelho G, Cortez VG, Guerrero RT. 2007. New morphological data on *Amauroderma brasiliense* (*Polyporales*, *Basidiomycota*). *Mycotaxon* 100: 177–183.
- Corner EJH. 1983. Ad Polyporaceas I. *Amauroderma* and *Ganoderma*. *Beihefte zur Nova Hedwigia* 75: 1–182.
- Decock C, Herrera Figueroa S. 2006. Neotropical *Ganodermataceae* (*Basidiomycota*): *Amauroderma sprucei* and *A. dubiopansum*. *Cryptogamie Mycologie* 27: 3–10.
- Drechsler-Santos ER, Groposo C, Loguerio-Leite C. 2008. Additions to the knowledge of lignocellulolytic basidiomycetes in forests from Santa Catarina, Southern Brazil. *Mycotaxon* 103: 197–200.
- Furtado JS. 1967. Some tropical species of *Ganoderma* with light colored context. *Persoonia* 4: 379–389.
- Furtado JS. 1968. Revisão do Gênero *Amauroderma* (*Polyporaceae*). Estudos baseados nas microestruturas do basidiocarpo. PhD Thesis, Universidade de São Paulo, São Paulo (Brazil). 384 p.
- Furtado JS. 1981. Taxonomy of *Amauroderma* (*Basidiomycetes*, *Polyporaceae*). *Memoirs of the New York Botanical Garden* 34: 1–109.
- Gibertoni TB, Cavalcanti MAQ. 2003. A mycological survey of the *Aphylllophorales* (*Basidiomycotina*) of the Atlantic Rain Forest in the State of Pernambuco, Brazil. *Mycotaxon* 87: 203–211.
- Gibertoni TB, Ryvar den L, Cavalcanti MAQ. 2004. Poroid fungi (*Basidiomycota*) of the Atlantic Rain Forest in Northeast Brazil. *Synopsis Fungorum* 18: 33–43.
- Gibertoni TB, Santos PJP, Cavalcanti MAQ. 2007. Ecological aspects of *Aphylllophorales* in the Atlantic rain forest in northeast Brazil. *Fungal Diversity* 25: 49–67.
- Gibertoni TB, Bernicchia A, Ryvar den L, Gomes-Silva AC. 2008. Bresadola's polypore collection at the Natural History Museum of Trento, Italy 2. *Mycotaxon* 104: 321–323.
- Gilbertson RL, Ryvar den L. 1986. North American polypores. Volume 1. *Abortiporus* – *Lindtneria*. Oslo, Fungiflora. 433 pp.
- Góes-Neto A. 1999. Polypore diversity in the State of Bahia, Brazil: a historical review. *Mycotaxon* 72: 43–56.
- Góes-Neto A, Baseia Y. 2006. Filo *Basidiomycota*. In: Gusmão LP, Maia LC. *Diversidade e Caracterização dos Fungos do Semi-Árido Brasileiro*. Associação Plantas do Nordeste, Recife: 141–159.
- Góes-Neto A, Marques MFO, Andrade JD, Santos DS. 2003. Lignicolous aphylllophoroid *Basidiomycota* in an Atlantic Forest fragment in the semi-arid Caatinga region of Brazil. *Mycotaxon* 88: 359–364.
- Groposo C, Loguerio-Leite C. 2005. Contribution to the lignocellulolytic fungi (*Basidiomycetes*) of the Atlantic Rain Forest in Southern Brazil. *Mycotaxon* 92: 103–106.
- Gulaid H, Ryvar den L. 1998. Two new species of *Amauroderma* (*Ganodermataceae*, *Basidiomycetes*). *Mycologia Helvetica* 10: 25–30.
- Hennings P. 1900. Fungi mattogrossenses a Dr. R. Pilger collecti 1899. *Hedwigia* 39: 134–139.

- Hennings P. 1904a. Fungi fluminensis a cl. E. Ule collecti. Hedwigia 43: 78–95.
- Hennings P. 1904b. Fungi amazonici. Hedwigia 43: 154–186.
- Hennings P. 1904c. Fungi S. Paulensis III. Hedwigia 43: 197–209.
- Holmgren PK, Holmgren NH. 1998 Index Herbariorum: New York Botanical Garden's Virtual Herbarium. Available at: <http://sweetgum.nybg.org/ih/Holmgren>.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the Fungi. 10th ed. CAB International, Wallingford. 771 pp.
- Loguercio-Leite C, Wright JE. 1991. Contribution to a biogeographical study of the Austro-american xylophilous polypores (*Aphylllophorales*) from Santa Catarina Island, SC, Brazil. Mycotaxon 41: 161–166.
- Maia HS. 1960. Fungos diversos. Publicações do Instituto de Micologia do Recife 267: 1–51.
- Maia LC, Yano-Melo AM, Cavalcanti MAQ. 2002. Diversidade de Fungos no Estado de Pernambuco. In: Tabarelli M, Silva JMC. Diagnóstico da Biodiversidade de Pernambuco. Secretaria de Ciência, Tecnologia e Meio Ambiente e Editora Massangana, Recife: 15–50.
- Meijer AAR de. 2006. Preliminary list of macromycetes from the Brazilian State of Paraná. Boletim do Museu Botânico Municipal 68: 1–55.
- Moncalvo JM, Ryvardeen L. 1997. A nomenclatural study of the *Ganodermataceae* Donk. Oslo, Fungiflora. 114 pp.
- Núñez M, Ryvardeen L. 2000. East Asian Polypores. Volume 1. Oslo, Fungiflora. Synopsis Fungorum 13: 1–168.
- Rajchenberg M. 1987. Type studies of *Polyporaceae* (*Aphylllophorales*) described by J. Rick. Nordic Journal of Botany 7: 553–568.
- Rajchenberg M, Meijer AAR de. 1990. New and noteworthy polypores from Paraná and São Paulo States, Brazil Mycotaxon 38: 173–185.
- Rick, J. 1938. O gênero *Polystictus* no Rio Grande do Sul. Anais da 1^a Reunião Sul-Americana de Botânica 2: 251–270.
- Rick, J. 1960. *Basidiomycetes* Eubasisii in Rio Grande do Sul, Brasília 4. *Meruliaceae*, *Polyporaceae*, *Boletaceae*. Iheringia, série botânica, 7: 193–295.
- Ryvardeen L. 1984. Type studies in the *Polyporaceae* 16. Species described by J.M. Berkeley, either alone or with other mycologists, from 1856 to 1886. Mycotaxon 20: 329–363.
- Ryvardeen L. 1985. Type studies in the *Polyporaceae* 17. Species described by W.A. Murrill. Mycotaxon 23: 169–198.
- Ryvardeen L. 1990. Type studies in the *Polyporaceae* 22. Species described by C.G. Lloyd in *Polyporus*. Mycotaxon 38: 83–102.
- Ryvardeen L. 1991. Genera of Polypores: nomenclature and taxonomy. Fungiflora, Oslo. 363 pp.
- Ryvardeen L. 2004a. Studies in Neotropical polypores 19. Two wood-inhabiting *Amauroderma* species. Synopsis Fungorum 18: 57–61.
- Ryvardeen L. 2004b. Neotropical Polypores: Part 1. Introduction, *Ganodermataceae* & *Hymenochaetaceae*. Oslo, Fungiflora. 227 pp.
- Ryvardeen L, Johansen I. 1980. A preliminary flora of East Africa. Oslo, Fungiflora. 636 pp.
- Ryvardeen L, Meijer AAR de. 2002. Studies in Neotropical polypores 14 – new species from the state of Parana, Brazil. Synopsis Fungorum 15: 34–69.
- Silveira RMB, Guerrero RT. 1991. *Aphylllophorales* poliporóides (*Basidiomycetes*) do Parque Nacional de Aparados da Serra, Rio Grande do Sul. Boletim do Instituto de Biociências 48: 1–127.
- Silveira RMB, Reck, MA, Graf LV, Sá FN. 2008. Polypores from a Brazilian pine Forest in Southern Brazil: pileate species. Hoehnea 35: 619–631.

- Singer R, Araujo I, Ivory MH. 1983. The ectotrophic mycorrhizal fungi of the Neotropical Lowlands, especially Central Amazonia. *Beihefte zur Nova Hedwigia* 77: 1–352.
- Sotão HMP, Bononi VLR, Figueiredo TS. 1991. *Basidiomycetes* de manguezais da Ilha de Maracá, Amapá, Brasil. *Boletim do Museu Paraense Emílio Goeldi, sér. bot.*, 7(1): 109–114.
- Sotão HMP, Hennen JF, Gugliotta AM, Melo OA & Campos EL. 1997. Os Fungos – *Basidiomycotina*. In: Lisboa PLB. Caxiuanã. Museu Paraense Emílio Goeldi, Belém: 213–219.
- Sotão HMP, Gugliotta AM, Oliveira AP, Luz AB & Melo OA. 2002. Fungos poliporóides. In: Lisboa PLB. Caxiuanã. Populações tradicionais, Meio Físico e Diversidade Biológica. Museu Paraense Emílio Goeldi, Belém: 433–444.
- Sotão HMP, Campos EL, Gugliotta AM & Costa SPSE. 2003. Fungos Macroscópicos: *Basidiomycetes*. In: Fernandes MEB. Os manguezais da costa norte brasileira. Fundação Rio Bacanga, São Luís: 45–59.
- Sotão HMP, Gibertoni TB, Maziero R, Baseia I, Medeiros PS, Martins-Júnior A & Capelari M. 2008. Fungos macroscópicos da Floresta Nacional de Caxiuanã, Pará, Brasil: *Basidiomycota* (*Agaricomycetes*). In: Lisboa PLB. Caxiuanã: Desafios para conservação de uma Floresta Nacional na Amazônia. Museu Paraense Emílio Goeldi, Belém: 123–143.
- Steyaert RL. 1972. Species of *Ganoderma* and related genera mainly of the Bogor and Leiden Herbaria. *Persoonia* 7: 55–118.
- Torrend C. 1920. Les polyporacées du Bresil. *Broteria, série botânica*, 18: 121–142.
- Torrend C. 1938. As Polyporaceas do Estado da Bahia e Estados limítrofes. *Anais da Primeira Reunião Sul-Americana de Botânica* 2: 325–341.
- Zhao JD. 1989. The *Ganodermataceae* in China. *Bibliotheca Mycologica* 132: 1–176.

New records of four *Lecanora* species from China

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Abstract — New records of four lichen species from China, *Lecanora cinereocarnea*, *L. dispersogranulata*, *L. opiniconensis*, and *L. perflexuosa*, are reported. Photos of their thalli are provided.

Key words — *Lecanoraceae*, Asia, taxonomy

Introduction

The lichen genus *Lecanora* (*Lecanoraceae*) was originally established by Acharius (Luyken 1809). It is a heterogeneous assemblage of different groups, several of which probably deserve generic rank (Lumbsch et al. 2004). The *Lecanora subfusca* group, which is the core group, is characterized by the presence of oxalate crystals in the amphithecium and the production of atranorin and/or usnic acid in the cortex (LaGreca & Lumbsch 2001). Species in the *Lecanora coronulans* group are similar to the *L. subfusca* group but differ in having a pigmented hypothecium (Lumbsch et al. 1996). Some groups differ from the *L. subfusca* group in chemistry. For example, the *Lecanora dispersa* group is characterized by a secondary chemistry that usually contains xanthones but lacks atranorin, an endolithic (sometimes epilithic) white thallus, apothecia with mostly white or light-coloured rims, and by usually calcareous substrates (Fröberg 1997). The *Lecanora varia* group is well characterized by an usnic acid primary chemistry and the lack of atranorin (Śliwa & Wetmore 2000). Also included in *Lecanora* is the subgenus *Placodium*, characterized by rosulate to lobate squamulose thalli that lack atranorin but usually have usnic acid in the upper cortex and lack oxalate crystals in the amphithecium (Ryan et al. 2004).

During our study of *Lecanora* in China, an unreported species belonging to subgenus *Placodium* — *Lecanora opiniconensis* — was discovered. At the same time we found three other new records that belong to *L. subfusca* group: *L. cinereocarnea*, *L. dispersogranulata*, and *L. perflexuosa*.

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Material and methods

The specimens examined are preserved in SDNU (Lichen Section of Botanical Herbarium, Shandong Normal University). A stereo-microscope (COIC XTL7045B2) and a polarizing microscope (OLYMPUS CX41-32) were routinely used for the morphological and anatomical studies on all materials. Photos of the thalli were taken with an OLYMPUS SZX12 with DP70. The chemical constituents were identified using thin layer chromatography (TLC) (Culberson 1972).

The new records

1. *Lecanora cinereocarnea* (Eschw.) Stizenb.,

Ber. Thätigk. St. Gall. Naturw. Ges. 1889–90: 218 (1890)

FIGURE 1A

Thallus yellowish gray, continuous, rough to verruculose, margin definite, prothallus white. Apothecia abundant, usually crowded, sessile, at first concave becoming flat, 0.4–1.7 mm in diam.; discs brownish yellow, epruinose; margins concolorous with the thallus, thick, smooth to verrucose. Amphithecium: cortex distinct, gelatinous, containing large crystals insoluble in KOH. Epihymenium brown, with coarse granules soluble in KOH, 5–10 µm tall. Hymenium hyaline, 50–60 µm tall, paraphyses simple, slightly thickened at the tip. Hypothecium hyaline, 50–90 µm thick. Ascospores simple, hyaline, $7.5\text{--}12.5 \times 4.5\text{--}7.5$ µm.

CHEMISTRY: atranorin, gangaleoidin.

SUBSTRATE: corticolous.

COMMENTS — This species is characterized by the corticolous, crustose thallus, yellowish brown apothecial discs, extremely crowded small apothecia, a coarse granular epihymenium, an amphithecium containing large crystals, and the presence of gangaleoidin. The morphologically similar *Lecanora cinereofusca* contains pannarin instead of gangaleoidin.

Lecanora cinereocarnea has been reported from Japan, the Philippines, and South America (Miyawaki 1988). New to China.

SPECIMENS EXAMINED: CHINA. Gansu: Wen Country, Qiujiaba, alt. 2500m, on bark, 4 Aug. 2006, X.L. Shi & F. Yang, 061992 (SDNU); Wen Country, Qiujiaba, alt. 2600m, on bark, 4 Aug. 2006, C.L. Wang & L. Lü, 062082 (SDNU); Wudu Country, Pandi Town, Tielugou, alt. 1500m, on bark, 7 Aug. 2006, X.L. Shi et al., 062473 (SDNU).

2. *Lecanora dispersogranulata* Szatala,

Annls hist.-nat. Mus. natn. hung., n.s. 7: 46 (1956)

FIGURE 1B

Thallus yellowish white to yellow grey, thin to thick, rough, continuous to dispersed-verrucose, margin definite, prothallus absent. Apothecia sessile to constricted at the base, 0.6–1.3 mm in diam.; discs yellow to orange-brown, epruinose; margins concolorous with the thallus, thin, even to crenulate.

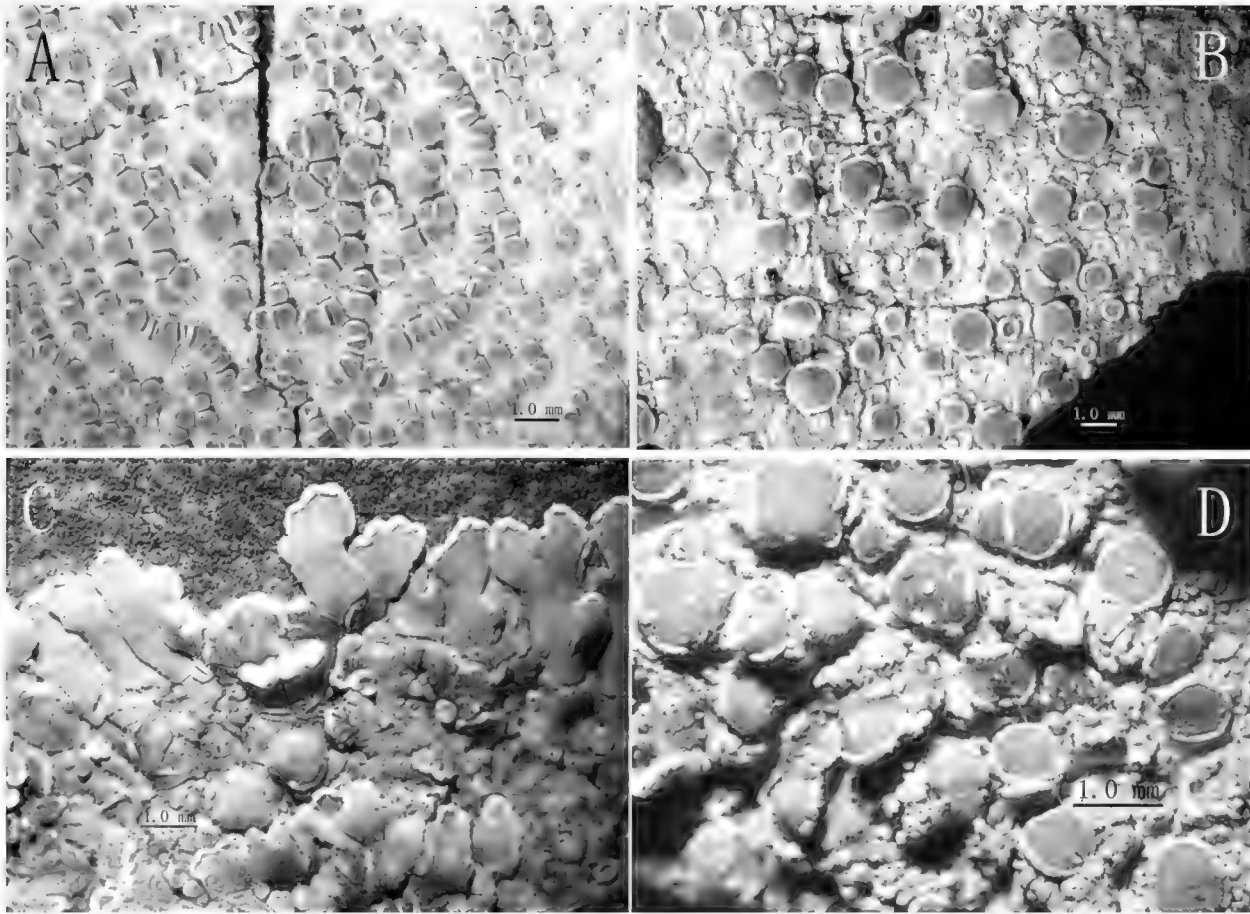


FIGURE 1. *Lecanora* species examined in the present study. Scale bar = 1 mm. A. *Lecanora cinereocarnea*, 062473 X.L. Shi et al. (SDNU); B. *Lecanora dispersogranulata*, 060996-2 F. Yang & X.L. Shi (SDNU); C. *Lecanora opiniconensis*, 20072799 F. Yang (SDNU); D. *Lecanora perflexuosa*, L397 Y.J. Li & W. Fu (SDNU)

Amphithecium: cortex distinct, 20–25 μm laterally, 25–35 μm at base, containing large crystals insoluble in KOH. Epihymenium yellowish brown, containing coarse granules, 12.5 μm tall. Hymenium hyaline, 55 μm tall, paraphyses slightly thickened apically. Hypothecium yellowish. Ascospores simple, hyaline, ellipsoid, 10–12.5 \times 6.5–7.5 μm .

CHEMISTRY: atranorin, 2'-O-methylperlatolic acid.

SUBSTRATE: corticolous.

COMMENTS — The species is characterized by a corticolous, verruculose thallus, comparatively large apothecia that are constricted at the base, crenulate apothecial margins, and the presence of 2'-O-methylperlatolic acid. In containing 2'-O-methylperlatolic acid, our specimen resembles *L. helva*, but the latter has smaller apothecia and ascospores.

Lecanora dispersogranulata was described from New Guinea and also reported from Australia (Lumbsch et al. 2004). New to China.

SPECIMENS EXAMINED: CHINA. Gansu: Zhouqu Country, huacaopoxigou, alt. 3300m, on wood, 29 Jul. 2006, F. Yang & X.L. Shi, 060996-2 (SDNU).

3. *Lecanora opiniconensis* Brodo, Mycotaxon 26: 309 (1986)

FIGURE 1C

Thallus placodioid, areolate to squamulose, yellowish to grayish green; lobes plane, 0.8–1.5 mm wide, lobe tips usually becoming darker yellow or pale brown to orange, lightly pruinose; prothallus absent. Apothecia adnate, soon constricted, 0.5–2.0 mm in diam.; discs orangish yellow or yellowish brown, epruinose, plane to convex; margins concolorous with the thallus to pale green, slightly pruinose or not, entire, flexuous. Amphithecium: cortex hyaline, 25–50 μm thick, containing small crystals soluble in KOH. Epihymenium yellowish brown, with abundant fine granules, 12.5–15 μm tall. Hymenium hyaline, 45–50 μm tall. Hypothecium hyaline, 25–47.5(–100) μm thick. Ascospores simple, hyaline, 6–11 \times 5–7 μm .

CHEMISTRY: usnic acid, placodiolic acid.

SUBSTRATE: saxicolous.

COMMENTS — This species is characterized by the saxicolous, squamulose thallus, darker yellow lobe tips, orangish brown apothecial discs, the fine granular epihymenium, and the presence of usnic acid and placodiolic acid. Other placodioid species of *Lecanora* (e.g., *L. muralis* and *L. polytropa*) can be easily distinguished from *L. opiniconensis* by anatomical features and chemistry.

Lecanora opiniconensis has been reported from North America and Asia (Ryan et al. 2004). New to China.

SPECIMENS EXAMINED: CHINA. Shannxi: Mt. Taibaishan, Fangyangsi, alt. 3300m, on rock, 4 Aug. 2005, C.L. Wang & F. Yang, TBW400 (SDNU); Ningxia: Mt. Helanshan, Suyukou, Toudaosong, alt. 2450m, on rock, 22 Aug. 2007, F. Yang, 20072799 (SDNU).

4. *Lecanora perflexuosa* (Räsänen) H. Miyaw.,

Journ. Hattori Bot. Lab. 64: 320 (1988)

FIGURE 1D

Thallus whitish grey with green or yellowish white, moderately thick, areolate, continuous, smooth to slightly verrucose; cortex thin, 5–12.5 μm thick; prothallus absent. Apothecia abundant, generally crowded, sessile or slightly constricted at base, 0.3–2.3 mm in diam.; discs yellowish brown to reddish brown, epruinose, flat to slightly convex; margins concolorous with the thallus, usually thin, entire to flexuose, smooth to verruculose, occasionally crenate. Amphithecium: with small crystals insoluble in KOH, cortex hyaline, inspersed, indistinct. Epihymenium yellowish to reddish brown, without granules, 10 μm tall. Hymenium hyaline, 60–100 μm tall. Paraphyses slightly thickened. Hypothecium hyaline, 100 μm thick. Ascospores simple, hyaline, ellipsoid, 7.5–15.5 \times 3.5–7.5 μm .

CHEMISTRY: atranorin, zeorin.

SUBSTRATE: corticolous.

COMMENTS — This species is characterized by the corticolous, greenish gray thallus, egranular epihymenium, and the presence of zeorin. It is similar to *L. megaloscheila* and *L. allophana*, but *L. megaloscheila* has a granular epihymenium and *L. allophana* does not contain zeorin (Miyawaki 1988).

Lecanora perflexuosa has been reported from Japan and Korea (Miyawaki 1988). New to China.

SPECIMENS EXAMINED: CHINA. Shannxi: Mt. Taibaishan, Zhongshansi, alt. 1650 m, on bark, 1 Aug. 2005, Y.J. Li & W. Fu L397 (SDNU); Ziyangtai, alt. 2300 m, 2 Aug. 2005, Y.J. Li & W. Fu L428 (SDNU).

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Literature cited

- Brodo IM. 1984. The North American species of the *Lecanora subfusca* group. *Beih. Nova Hedwigia* 79: 63–185.
- Fröberg L. 1997. Variation of the *Lecanora dispersa* group in South Sweden. *Symbolae Botanicae Upsalienses* 32: 29–34.
- LaGreca S, Lumbsch HT. 2001. Three species of *Lecanora* new to North America, with notes on other poorly known lecanoroid lichens. *The Bryologist* 104: 204–211.
- Lumbsch HT, Guderley R, Elix JA. 1996. A revision of some species in *Lecanora sensu stricto* with a dark hypothecium (*Lecanorales*, *Ascomycotina*). *The Bryologist* 99: 269–291.
- Luyken JA. 1809. *Tentamen historiae lichenum*. Göttingen. 102 p.
- Lumbsch HT, Elix JA. 2004. *Lecanora*. In: McCarthy PM, Mallett K (eds.): *Flora of Australia*, Volume 56 A, Lichens 4. ABRS, CSIRO Australia, Melbourne. pp. 11–62.
- Miyawaki H. 1988. Studies on the *Lecanora subfusca* group in Japan. *J. Hattori Bot. Lab.* 64: 271–326.
- Ryan BD, Lumbsch HT, Messuti MI, Printzen C, Śliwa L, Nash TH III. 2004. *Lecanora*. In: Nash TH III, Ryan BD, Diederich P, Gries C, Bungartz F (eds.): *Lichen Flora of the Greater Sonoran Desert Region*, Vol. 2. Lichens Unlimited, Arizona State University, Tempe, Arizona. pp. 176–286.
- Śliwa L, Wetmore CM. 2000. Notes on the *Lecanora varia* group in North America. *The Bryologist* 103: 475–492.

Fungi on higher plants of the upper limit of the alpine zone: new species from Tian Shan

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Abstract — Fifty-two taxa of fungi were noted at the upper limit of closed vegetation in Zailiyskiy Alatau Mts. (Tian Shan) in Kazakhstan. Of them three new species are described: *Protoventuria juniperina*, *Trichometasphaeria barriae*, and *Veronaea thylacospermi*. A new combination, *Didymosphaerella spartii*, with a possible *Sclerostagonospora* anamorph is proposed.

Key words — parasite, saprotroph, distribution, taxonomy

Introduction

A study of fungal diversity at the upper alpine plant limit was begun in Kazakhstan in 2005. Among the 52 taxa of fungi noted at the upper limit of closed vegetation in Tian Shan, three new species have already been described: *Cyathicula brunneospora* and *Pirottaea atrofusca* (Chlebická & Chlebicki 2007) and *Microbotryum adenopetalae* (Lutz et al. 2008). Below I propose three additional species — *Protoventuria juniperina*, *Trichometasphaeria barriae*, *Veronaea thylacospermi* — and one new combination, *Didymosphaerella spartii*, with a possible *Sclerostagonospora* anamorph.

Materials and methods

STUDY AREA: The terminal glacier foreland of the Issyk valley in Zailiyskiy Alatau Mts. (Tian Shan) near Almaty in southern Kazakhstan was investigated. The study was conducted on the slope of a marginal moraine (inactive ground ca 300 m before the ice margin) of the uppermost small basin at the glacier front at 3436 m elev., N43°07'52.5" E77°30'25". A distinct limit of closed vegetation was present. All native plant habitats comprised initial soil partially covered by granite rocks of various sizes (1 cm–1 m diam).

METHODS: Dried material was examined under a zoom stereo microscope (Nikon SMZ 1500), and also with a light microscope Labophot 2 (Nikon) and Olympus BX-51,

at magnifications of 1000× and 2000×, and in some cases using Nomarski contrast (DIC). Microscopical observations and measurements of freehand longitudinal ascocarp sections were made in water, 3% KOH, or Lugol's solution (IKI: 1% iodine, 3% KI in water). Gelatinous sheaths of free ascospores were observed in India ink. Materials are deposited at the W. Szafer Institute of Botany of Polish Academy of Sciences in Kraków (Poland).

Species

***Didymosphaerella spartii* (Fabre) Chleb., comb. nov.**

FIGURES 1 A–B

MYCOBANK MB 509494

BASEONYM: *Didymosphaeria spartii* Fabre, Ann. Sci. Nat., Bot., sér. 6, 9: 83, 1879.

≡ *Sphaeria spartii* Castagne, Cat. Pl. Marseille: 169,
1845, nom illegit., non Nees : Fr. 1823.

≡ *Microthelia spartii* (Fabre) Kuntze, Revis Gen. Pl. 3(2): 498, 1898.

≡ *Montagnula spartii* (Fabre) Aptroot, Nova Hedwigia 60: 342, 1995.

= *Didymosphaeria elbursensis* Petr., Ann. Naturh. Mus. Wien. 50: 429, 1940.

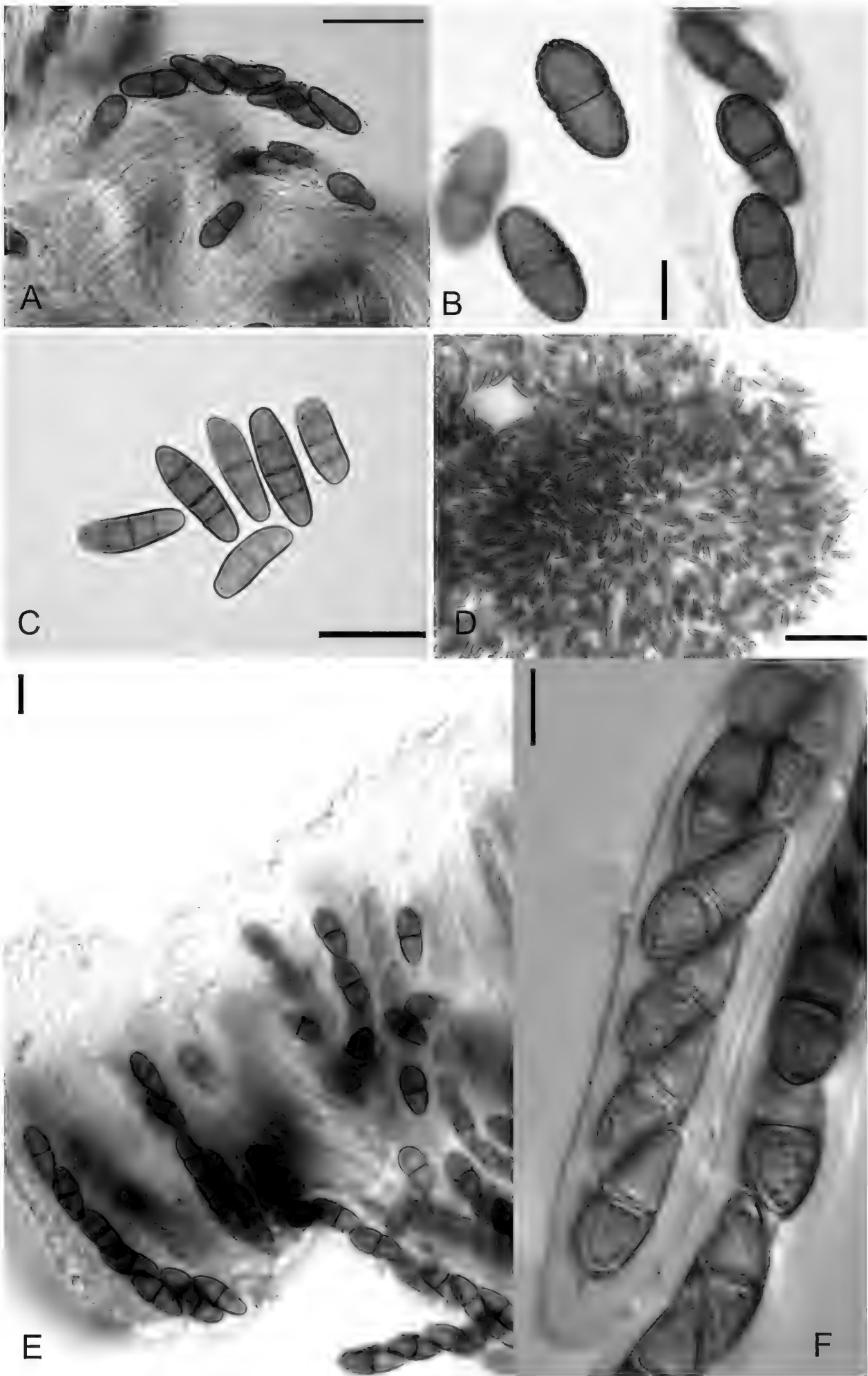
ASCOMATA globose, ca 240 µm diam., peridium wall widest in lower part, textura angulata, ASCI bitunicate, clavate 110–130 × 20–21 µm (FIG. 1A), ASCOSPORES 1-septate, slightly constricted at the septum, clear reddish brown, hemispores unequal, upper hemispore wider and slightly pointed, (20–)24–27 × 11–12 µm, wall thick and finely verruculose (FIG. 1B, left side), gelatinous sheath 3–7 µm thick, uniseriate in the lower part and biseriate in upper part of ascus, INTERASCAL HYPHAE (cellular pseudoparaphyses) narrow, 1–1.4 µm diam. in its lower part and 2.2 µm diam. in upper part.

SPECIMENS EXAMINED: Kazakhstan, Tian Shan: Zailiyskiy Alatau Mts., valley of Issyk (Yssyk) river, at the moraine, N43°07'52.5", E77° 30'25", 3436 m elev., 3 August 2005, on stems of *Carex griffithii* and *Anthoxanthum alpinum*, coll.: A. Chlebicki, KRAM "F" 46581.

COMMENTS — Barr (2001) lectotypified the genus *Didymosphaerella* Cooke by *Didymosphaerella longipes* (Trab.) Cooke. Placing the genus in her new family *Montagnulaceae* M.E. Barr, she transferred *Montagnula* Berl. species with two celled ascospores to *Didymosphaerella*. The Tian Shan fungus is identical to *Didymosphaeria elbursensis* (FIG. 1B right side) noted on *Festuca sulcata* in Mt. Damawed in Elburs Mts. (Iran). Aptroot (1995a,b) synonymized *D. elbursensis* with *Montagnula spartii*, including also species that he considered morphologically similar occurring on palm leaves, brooms, *Ephedraceae*, and *Poaceae*. Aptroot (1995a) pointed out that ascospores in *M. spartii* have thicker walls than those in *M. opulenta* (De Not.) Aptroot [= *D. opulenta* (De Not.) Checa & M.E. Barr, which Barr (2001) restricted to collections from *Opuntia*].

FIG. 1. *Didymosphaerella spartii*: A. asci; B. ascospores from Tian Shan specimen (left) and Elburs Mts. specimen (right). *Sclerostagonospora* sp.: C, D. conidia. *Protoventuria juniperina*: E. asci; F. ascospores.

Scale bars: A= 30 µm, C = 15 µm, E = 60 µm, other = 10 µm



Both the Tian Shan and Elburs *D. spartii* specimens possess thick walled ascospores (FIG.1B), but the ascospore size and shape differ from other taxa referred to *M. spartii* by Aptroot (1995a). Aptroot (1995a) mentioned as host plants some other grasses such as *Festuca brachyphylla*, *Puccinellia angustata*, and *Stipa himalaica*. *Didymosphaerella spartii* has been noted in North America, Greenland and Asia.

***Sclerostagonospora* sp.**

FIGURES 1 C–D

CONIDIOMATA immersed, CONIDIA pale brown with surrounded tips, three septate, $14\text{--}19 \times 4\text{--}5 \mu\text{m}$ (FIG. 1 C,D).

SPECIMENS EXAMINED: Kazakhstan, Tian Shan: Zailiyskiy Alatau Mts., valley of Issyk (Yssyk) river, at the moraine, N43°07'52.5", E77° 30'25", 3436 m elev., 3 August 2005, on stems of *Festuca coelestis*; *Anthoxanthum alpinum*, coll.: A. Chlebicki, KRAM "F".

COMMENTS — The close occurrence of this *Sclerostagonospora* species with the Tian Shan fungus suggests it as a possible *Didymosphaerella spartii* anamorph.

***Protoventuria juniperina* Chleb., sp. nov.**

FIGURES 1 E– F

MYCOBANK MB 4399

Mycelium superficialum vel epidermide tectum, melanostictum, setae myceliales nullae. Ascomata 120–200 μm crassa, globosa, setae atrobrunneae 70–100 μm longae, 3 μm crassae. Asci bitunicati, clavati 70–76 \times 13–14 μm , ascosporae olivaceae vel viride-olivaceae, 13–20 \times 7–8 μm , 1-septatae, ad septum constrictae, exosporio laevi. Pseudoparaphyses septatae, ramosae, 1 μm crassae, ascos superantes.

TYPE: Kazakhstan, Tian Shan: Zailiyskiy Alatau Mts., valley of Issyk river, at the moraine, N43°07'52" E77°30'25", 3436 m elev., on dead leaves of *Juniperus sibirica*, 3 Aug. 2005, coll.: A. Chlebicki, Holotype-KRAM "F" 46550.

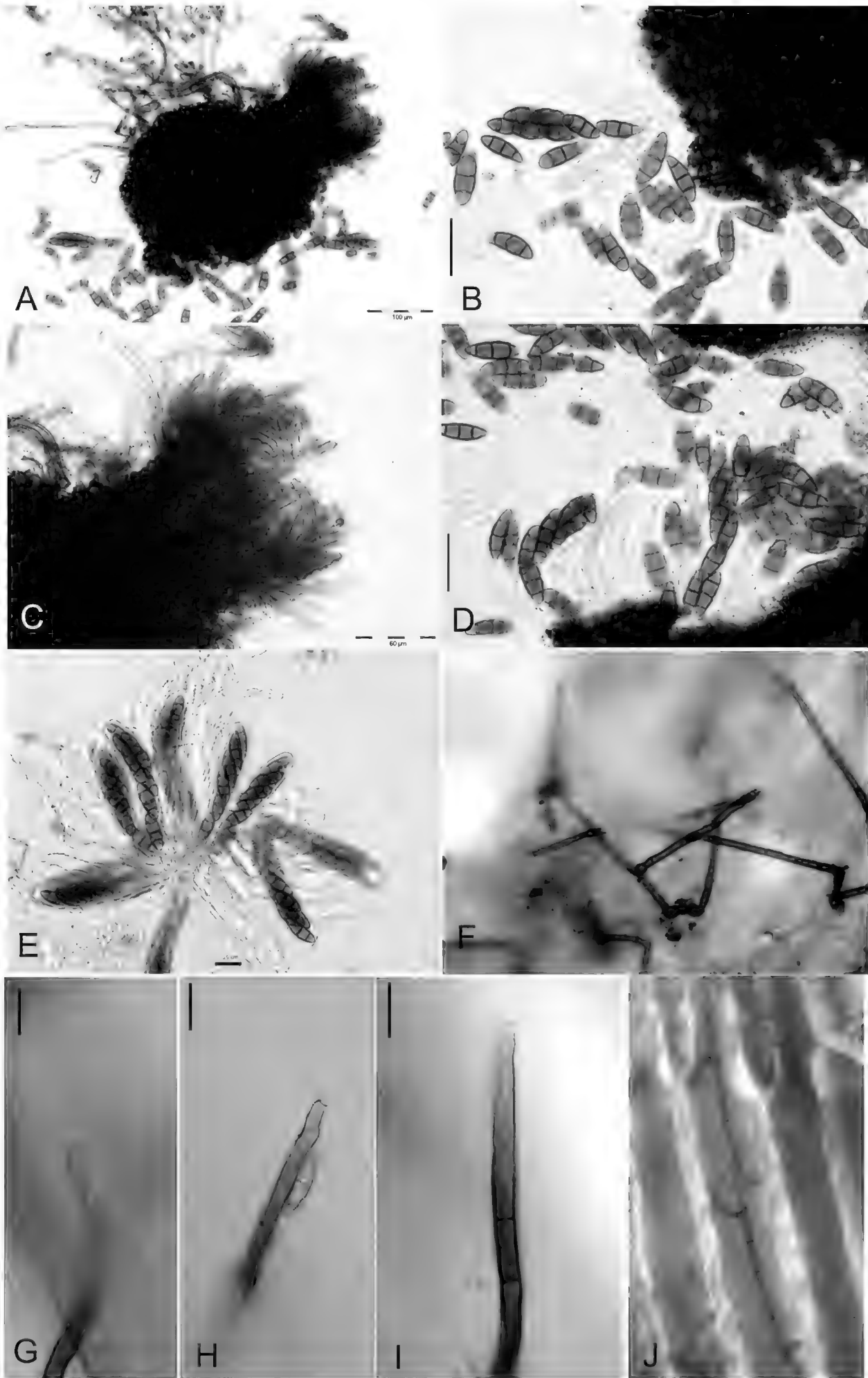
ETYMOLOGY — The specific epithet refers to the host plant.

MYCELIUM superficial, producing subcuticular hyphae, sometimes forming dark blotches. ASCOMATA globose, 120–200 μm diam., surface strongly setose, SETAE 70–100 μm long, 3 μm wide at the base, pointed, ASCI bitunicate, clavate 70–76 \times 13–14 μm , ASCOSPORES olivaceous to greenish, septate, upper hemispore slightly wider, smooth, 13–20 \times 7–8 μm , constricted at the septum, contents finely guttulate (FIG.1F). HAMATHECIUM: pseudoparaphyses sparse, septate and branched, ca 1 μm wide, exceeding asci (FIG.1E).

COMMENTS — *Protoventuria juniperina* somewhat resembles species in the *Herpotrichiellaceae*, which, however, possess poorly developed interascal elements or lack tissues (Barr 1972, Untereiner et al. 1995). The fungus from Tian

FIG. 2. *Trichometasphaeria barrii*: A. ascoma; B. ascospores, C. ostiole with setae, D. hamathecium and ascospores, E. asci. *Veronaea thylacospermi*: F. conidiophores with inflated basal cell, G. conidium, H, I. rachis with scattered, denticle-like conidiogenous loci, J. mycelial hypha.

Scale bars: A = 100 μm ; C = 60 μm ; B, D = 40 μm ; E = 25 μm ; G, H, I = 10 μm



Shan is referred to *Pleosporales* rather than *Dothideales* based on the presence of a distinct hamathecium. It is similar to species from the genus *Protoventuria* Berl. & Sacc. (*Venturiaceae*), which possess hypostroma, intramatrical, and subcuticular hyphae. However the *Gibbera* Fr. species previously referred to subgenus *Venturioides* M.E. Barr that Barr (1989) transferred to *Protoventuria* have some superficial and intramatrical hyphae. Holm & Holm (1977) noted two venturiaceous fungi on *Juniperus communis* leaves: *Gibbera* sp. and *Seynesiella juniperi* (Desm.) G. Arnaud. *Gibbera* sp., which most closely resembles the Tian Shan fungus, differs by producing light greenish, fusiform ascospores.

***Trichometasphaeria barriiae* Chleb., sp. nov.**

FIGURES 2A–E

MYCOBANK MB 5561

Ascomata ex parte inclusa in substratum vel superficialia, gregaria, sphaeroidea 340–420 µm crassa, setae fuscae, apicibus pallidulis, septatae, curvatae, 70 µm longae. Peridium 24–44 µm crassum, textura angulare, asci clavati 120–140(–150) × 24–26(–27) µm, ascospores 42–44 × 10–14(–15) µm, uniseriatae, in parte superiore biseriatae, ellipsoideae, asymmetricae, apice obtusae, 3-septatae ad septum modice constrictae, brunneolae, extremis pallidulis, exosporio laevi. Pseudoparaphyses 2 µm latae, septatae, ramosae.

TYPE: Kazakhstan, Tian Shan: Zailiyskiy Alatau Mts., valley of Issyk river, at the moraine, N43°07'52" E77°30'25", 3436 m elev., on tips of stems and leaves of *Waldheimia tridactylites*, 3 Aug. 2005, coll.: A. Chlebicki, Holotype-KRAM "F" 46551, Isotype KRAM "F" 46552.

ETYMOLOGY — the epithet refers to the late Margaret E. Barr.

ASCOMATA (FIG. 2A) partially embedded in the substratum, rarely erumpent, gregarious, 340–420 µm wide, ca 500 µm high, wall 24–44 µm thick, composed of an external dark layer with 3 rows of cells and an internal light layer with 2–3 rows of cells, textura angularis, subiculum absent, with a distinct OSTIOLE ca 160 µm diam, 90–100 µm high, covered by short (up to 70 µm long and 4–6 µm wide) straight or slightly curved septate setae (FIG. 2C), paler at the tips and sometimes slightly rough, surface of ascomata covered by very long, curved, darker, septate, thick walled and downward growing hyphae, 5–6 µm diam. at the base, ASCI clavate, 120–140(–150) × 24–26(–27) µm (FIG. 2E), ASCOSPORES 37–44(–45) × 10–14(–15) µm, 3-septate, constricted at the supramedian septum, slightly asymmetric, pale brown, distal cells slightly paler (FIG. 2B) PSEUDOPARAPHYSES ca 2 µm diam., branched and septate, very abundant in the centrum, hyaline, their cells inside granulate (FIG. 2D).

COMMENTS — Yuan & Barr (1994) described a new species, *T. papillisetosa* Z.Q. Yuan & M.E. Barr, also from Tian Shan (China) but on decorticated branches of *Pentaphylloides fruticosa*. Both *T. barriiae* and *T. papillisetosa* produce similar ascomata with septate, erect setae with paler tips and larger ascospores. The smooth-walled ascospores help distinguish *T. barriiae* from *T. papillisetosa*, which has verrucose ascospores.

***Veronaea thylacospermi* Chleb., sp. nov.**

FIGURES 2F–J

MYCOBANK MB 10387

Coloniae hypophyllae, effusae, brunneae. Conidiophora singularia, erecta, recta vel flexuosa, 1–3(–8) septata, pallide brunnea, usque 35–100 µm longa, 3–4 µm crassa, sub conidiophoris ad 6–10 µm, apicem versus pallidiora. Cellulae conidiogenae 0.3 µm longae et 0.5 µm latae. Conidia obclavata, subhyalina, verruculosa, 1-septata, basi obconico-truncata, apicem versus rotundata 12–14 × 3–4 µm.

TYPE: Kazakhstan, Tian Shan: Zailiyskiy Alatau Mts., valley of Issyk river, at the moraine, N43°07'52" E77°30'25", 3436 m elev., on leaves of *Thylacospermum caespitosum*, 3 Aug. 2005, coll.: A. Chlebicki, **Holotype**-KRAM "F" 46601.

ETYMOLOGY — Refers to the host plant, *Thylacospermum caespitosum*.

CONIDIOPHORES simple, smooth, brown, 1–3(–8) septate, 35–100 × 3–4 µm, basal cell inflated 6–10 µm wide (FIG. 2F), fertile part taller than basal part, forming slightly flexuose rachis with scattered, hyaline and small. Apically pointed denticle-like CONIDIOGENOUS LOCI, 0.3 µm high, 0.5 µm wide (FIG. 2H,I). CONIDIA hyaline 12–14 × 3–4 µm, two celled, lower cell longer and wider than upper one, wall slightly verruculose (FIG. 2G). Paler mycelial hyphae distributed inside host cells (FIG. 2J).

COMMENTS — No *Veronaea* species have been previously reported from *T. caespitosum*. The conidia of *V. thylacospermi* are similar to those of *V. caricis* M.B. Ellis, illustrated by Ellis (1976). This fungus is a transitional form between the genera *Veronaea* and *Myrmecridium* (Arzanlou et al. 2007); however its two celled conidia devoid of gelatinous sheath indicate a relationship with *Veronaea*.

Acknowledgments

Margaret E. Barr[†] helped me establish the taxonomical status of the genus *Trichometasphaeria*. I also thank reviewers Sabine Huhndorf and Hans Otto Baral. I especially thank Shaun Pennycook for important comments and suggestions.

Literature cited

- Aptroot A. 1995a. Redisposition of some species excluded from *Didymosphaeria* (Ascomycotina). *Nova Hedwigia* 60: 325–379.
- Aptroot A. 1995b. A monograph of *Didymosphaeria*. *Stud. Mycol.* 37: 1–160.
- Arzanlou M, Groenewald JZ, Gams W, Braun U, Shin H-D, Crous PW. 2007. Phylogenetic and morphotaxonomic revision of *Ramichloridium* and allied genera. *Stud. Mycol.* 58(1): 57–93.
- Barr ME. 1972. Preliminary studies on the *Dothideales* in temperate North America. *Contr. Univ. Michigan Herb.* 9(8): 523–638.
- Barr ME. 1989. The *Venturiaceae* in North America: revision and additions. *Sydowia* 41: 25–40.
- Barr ME. 2001. *Montagnulaceae*, a new family in the *Pleosporales*, and lectotypification of *Didymosphaerella*. *Mycotaxon* 77: 193–200.
- Chlebická M, Chlebicki A. 2007. *Cyathicula brunneospora* and *Pirottaea atrofusca*, two new *Helotiales* from Tian Shan (Kazakhstan). *Mycotaxon* 100: 37–50.

- Ellis MB. 1976. More dematiaceous Hyphomycetes. CMI, Kew, Surrey. 507 pp.
- Holm K, Holm L. 1977. Nordic junipericolous *Ascomycetes*. Acta Universitatis Upsaliensis. Symb. Bot. Upsal. 21(3): 1–70.
- Lutz M, Piątek M, Kemler M, Chlebicki A, Oberwinkler F. 2008. Anther smuts of *Caryophyllaceae*: molecular analyses reveal further new species. Mycol. Res. 112: 1280–1296.
- Untereiner WA, Straus NA, Malloch D. 1995. A molecular-morphotaxonomic approach to the systematics of the *Herpotrichiellaceae* and allied black yeast. Mycol. Res. 99(8): 897–913.
- Yuan Z-Q, Barr ME. 1994. New ascomycetous fungi on bush cinquefoil from Xinjiang, China. Sydowia 46(2): 329–337.

Fungi on higher plants of the upper limit of the alpine zone in Tian Shan

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Abstract — Fifty-two taxa of microfungi were noted at the upper limit of closed vegetation in Zailiyskij Alatau Mts. (Tian Shan) in Kazakhstan, of which only 30% were saprobic species. Among the common and rare species were seven newly named taxa, six species new to science and one new combination. The complete annotated species checklist is available at <http://www.mycotaxon.com/resources/weblists.html>.

Key words — parasite, saprotroph, distribution, taxonomy

Introduction

The current study aims to assess microfungal diversity at the upper alpine plant limit in Tian Shan. The highly variable upper limit depends on many different factors, with different limits set for individual plants, plant communities, and closed vegetation (Grabherr et al. 1995). I investigated the limit of closed vegetation. Some information on fungi of the western part of Tian Shan has already been reported by Schwartzman (1962), Akhmedova (1966), Vasyagina (1977), Korbonskaya (1951, 1954), Salieva et al. (2002), Raitviir (2004), Chlebicki (2002, 2003, 2006, 2009), Chlebicki & Aime (2006), Chlebická & Chlebicki (2007), and Gaffyorov (2005). New species discovered since my research of the Zailiyskij Alatau Mts. began in 2005 are *Cyathicula brunneospora* and *Pirottaea atrofusca* (Chlebická & Chlebicki 2007), *Microbotryum adenopetalae* (Lutz et al. 2008), and *Protoventuria juniperina*, *Trichometasphaeria barriae*, and *Veronaea thylacospermi* (Chlebicki 2009).

Materials and methods

STUDY AREA: The terminal glacier foreland of the Issyk valley in Zailiyskij Alatau Mts. (Tian Shan) near Almaty in southern Kazakhstan was investigated. The study was conducted on the slope of a marginal moraine (inactive ground ca 300 m before the ice margin) of the uppermost small basin at the glacier front at 3436 m elev., N43°07'52.5" E77°30'25". A distinct limit of closed vegetation was present. The native plant habitats comprised initial soil partially covered by variously sized (1 cm–1 m diam) granite rocks. Material was collected from 16 permanent 2.5 × 2.5 m plots within a 10 × 10

m square (FIG. 1). Plants growing at the altitudinal limit belong to various growth forms such as cushion plants, mat forming forbs, rosette perennial plants, tussock graminoids, prostrate dwarf shrubs, and tiny bryophytes.

METHODS: Dried material was examined under a Nikon SMZ 1500 zoom stereo microscope and at magnifications of 1000× and 2000× under a Nikon Labophot 2 or Olympus BX-51 light microscope, with Nomarski contrast (DIC) occasionally used. Microscopical observations and measurements of freehand longitudinal ascocarp sections were made in water and 3% KOH mountants. Lugol's solution (IKI: 1% iodine, 3% KI in water), Melzer's reagent (MLZ), and 5% KOH were used to determine the apical ring reactions and character of setae. Gelatinous sheaths of free ascospores were observed in India ink. Materials are deposited at the W. Szafer Institute of Botany of Polish Academy of Sciences in Kraków (Poland) and the National Museum in Prague (Czech Republic).

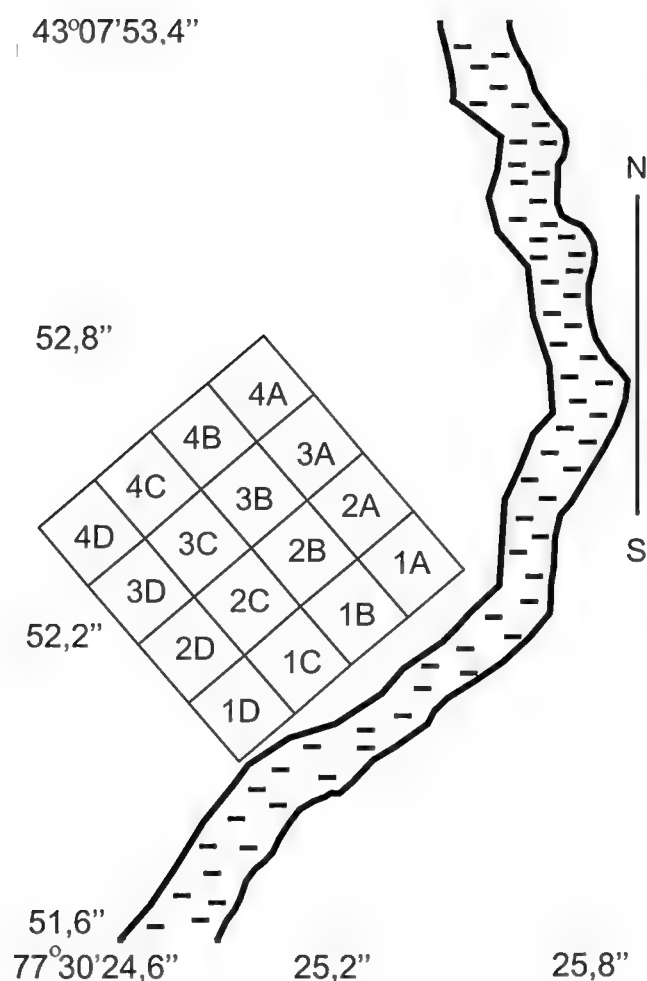


FIG. 1. The Tian Shan 10 m × 10 m permanent survey plot with 16 2.5 × 2.5 m quadrats (1A-4A, 1B-4B, 1C-4C, 1D-4D).

Results

Microfungi included 31 ascomycete species representing *Barrmaelia*, *Cainia*, *Cistella*, *Comoclathris*, *Cyathicula*, *Davidiella*, *Didymosphaerella*, *Glomerella*, *Hysteropezizella*, *Keissleriella*, *Lachnellula*, *Lophodermium*, *Mytilinidion*, *Nectriella*, *Phaeosphaeria*, *Phomatospora*, *Pirottaea*, *Pleospora*, *Protoventuria*, *Scutellinia*, *Trichometasphaeria* and *Wettsteinina* (*Pezizomycotina*); three rust species in *Melampsora*, *Microbotryum*, and *Puccinia* (*Pucciniomycotina*); a single *Ustilago* species (*Ustilagomycotina*); three *Agaricales* species in *Calyptralla*, *Lagarobasidium* and *Typhula*; and 14 mitosporic species representing *Alternaria*, *Botrytis*, *Cladosporium*, *Fusarium*, *Heteropatella*, *Hymenella*, *Periconia*, *Phoma*, *Seimatosporium*, and *Veronaea*. Many host plants were abundant enough for fungus persistence. The presence of parasites on single plants (e.g., *Lachnellula arida* on *Juniperus sibirica*, *Melampsora epitea* and *Seimatosporium lichenicola* on *Salix alata*) indicates long-range dispersal. Other fungi had restricted distributions in spite of their host plants being common in the investigated

area (e.g., *Ustilago striiformis* on *Anthoxanthum alpinum*, *Microbotryum adenopetalae* on *Silene adenopetala*, *Puccinia saxifragae* on *Saxifraga cernua*, *Lagarobasidium detriticum* on *Carex griffithii*). The greatest number of fungal species was noted on tussock plants such as *Carex griffithii*, *Festuca coelestis*, and *Anthoxanthum alpinum*.

Discussion

It is very difficult to describe all fungi linked with single host plant, as competition and niche differentiation influence the composition of the fungal-plant association (Neubert et al. 2006). The upper limit of closed vegetation can be compared with Gotelli’s (1991) metapopulation model, which shows the effect of propagule immigration during population size decrease. Chlebicki & Olejniczak (2007) noted that the number of fungal species on plants is directly proportional to the size of the host population. It is evident that host plants were accessible to fungus propagules originating from lower plant populations. The highest number of fungal species per host, however, were noted on the common tussock plants (TABLE 1).

TABLE 1. Number of fungi noted on investigated plants

PLANT SPECIES	NO. OF FUNGI	PLANT SPECIES	NO. OF FUNGI
1. <i>Anthoxanthum alpinum</i> Á. Löve & D. Löve	22	12. <i>Oxyria digyna</i> (L.) Hill	2
2. <i>Carex griffithii</i> Boott	28	13. <i>Pentaphylloides fruticosa</i> (L.) O. Schwarz	0
3. <i>Cerastium cerastoides</i> (L.) Britton	5	14. <i>Primula nivalis</i> Pall.	4
4. <i>Doronicum oblongifolium</i> DC.	0	15. <i>Pyrethrum karelinii</i> Krasch.	0
5. <i>Draba incurvata</i> A.N. Vassiljeva & Golosk.	3	16. <i>Salix alata</i> vica Kar. & Kir. ex Stschegl.	3
6. <i>Draba oreades</i> Schrenk	5	17. <i>Saussurea</i> sp.	5
7. <i>Dryadanthe tetrandra</i> (Bunge) Juz.	0	18. <i>Saxifraga cernua</i> L.	5
8. <i>Erigeron</i> sp.	0	19. <i>Saxifraga oppositifolia</i> L.	0
9. <i>Festuca coelestis</i> (St.-Yves) V.I. Krecz. & Bobrov	18	20. <i>Silene adenopetala</i> Raikova	9
10. <i>Juniperus sibirica</i> Burgsd.	3	21. <i>Thylacospermum caespitosum</i> (Cambess.) Schischk.	11
11. <i>Leontopodium leontopodium</i> (DC.) Hand.-Mazz.	1	22. <i>Waldheimia tridactylites</i> Kar. & Kir.	7

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Literature cited

- Akhmedova FG. 1966. Mikoflora Yugo-Zapadnykh otrogov Tian-Shanya. Autoref. dissertation kand. biol. nauk. Tashkent. 25 pp.
- Chlebicki A. 2002. Two cypericolous smut fungi (*Ustilaginomycetes*) from the Tian Shan and their biogeographic implications. *Mycotaxon* 83: 279–286.
- Chlebicki A. 2003. *Anthracoidea stenocarpae*, the orthographically correct name for a species described from Tian Shan. *Mycotaxon* 88: 469.
- Chlebicki A. 2006. Two species of smut fungi on *Polygonaceae* from Tian Shan, Kazakhstan. *Czech Mycol.* 58: 99–104.
- Chlebicki A. 2009. Fungi on higher plants of the upper limit of alpine zone: new species from Tian Shan. *Mycotaxon* 110: 443–450.
- Chlebicki A, Aime C. 2006. New distribution and host records for *Puccinia atrofusca* and other notable *Puccinia* species (*Uredinales*) from Central Asia. *Polish Bot. J.* 51: 87–91.
- Chlebická M, Chlebicki A. 2007. *Cyathicula brunneospora* and *Pirotaea atrofusca*, two new *Helotiales* from Tian Shan (Kazakhstan). *Mycotaxon* 100: 37–50.
- Chlebicki A, Olejniczak P. 2007. Symbiotic drift as a consequence of declining host populations. *Acta Biol. Crac. Ser. Bot.* 49(1): 89–93.
- Gafforov YS. 2005. Micromycetes on vascular plants in Namangan Region. Thesis of the PhD of Biol. Sci. Tashkent 2005.
- Gotelli JN. 1991. Metapopulation models: The rescue effect, the propagule rain, and the core-satellite hypothesis. *Amer. Naturalist* 38: 768–776.
- Grabherr G, Gottfried M, Gruber A, Pauli H. 1995. Patterns and current changes in alpine plant diversity. In: Chapin FS III, Körner Ch (Eds). *Arctic and alpine biodiversity: patterns, causes and ecosystem consequences*. Ecological Studies 113. Springer, Berlin, New York, p. 167–181.
- Korbonskaya JaI. 1951. Species novae *Uredinarum* a Republica Tadzhiķica. *Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk S.S.S.R.* 7: 178–181.
- Korbonskaja JaI. 1954. Rzhavichnije griby Tadzhiķistana. *Trudy Akad. Nauk Tadzhiķsk. SSR* 30: 1–95.
- Lutz M, Piątek M, Kemler M, Chlebicki A, Oberwinkler F. 2008. Anther smuts of *Caryophyllaceae*: molecular analyses reveal further new species. *Mycol. Res.* 112: 1280–1296.
- Neubert K, Mendgen K, Brinkmann H, Wirsel SGR. 2006. Only a few fungal species dominate highly diverse mycofloras associated with the common reed. *Appl. Envir. Microbiol.* 72(2): 1118–1128.
- Raitviir A. 2004. Revised synopsis of the *Hyaloscyphaceae*. *Scripta Mycol.* 20: 1–133.
- Salieva YaS, Kirgizbayeva KhM, Gulyamova M. 2002. Razpredelennye mikromitzetov po rastitel'nyy poyasam otrogov Yugo-Zapadnogo Tian-Shanya. In: Bioobrazie Yugo-Zapadnogo Tian-Shanya: okhrana i ratsional'noye izpol'zovaniye. International Conference. Tashkent, p. 191–194.
- Schwartzman SR. 1962. Flora sporovyykh rasteniy Kazakhstana 2. Golovnevye griby (Smut fungi). IAN Kazakhskoy SSR, Alma Ata. 369 pp.
- Vasyagina MP. 1977. Additions to the *Ustilaginales* flora of Kazakhstan. *Bot. Mater. Gerb. Bot. Akad. Nauk Kazakhsk. SSR* 10: 101–105.

Additions to our knowledge of lichens and lichenicolous fungi in Iran

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Abstract — In this study 23 species of lichens and lichenicolous fungi are recorded as new to Iran, of which 12 were collected from the province of Ilam and 11 from six other provinces. The full checklist is available on <http://www.mycotaxon.com/resources/weblists.html>.

Key words — *Ascomycota*, Asian lichens, floristics, lichenized fungi

Introduction

A preliminary lichen checklist of Iran (Seaward et al. 2004) included 396 lichens and eight lichenicolous fungi based mainly on literature records and studies of voucher material. It also summarized the literature on Iranian lichens. Subsequently, a revised checklist of lichenized, lichenicolous, and allied fungi for Iran (Seaward et al. 2008) added 136 species. Recently, the first author has collected intensively in several provinces, especially Ilam, Lorestan, and Kuzestan. Here we report the discovery of 23 new species for the lichen flora of Iran, 12 of which are recorded from the province of Ilam and 11 from the provinces of Chaharmahal & Bakhtiari (2 species), Gorgan (1 species), Kerman (2 species), Khuzestan (1 species), Lorestan (4 species), and Zanjan (1 species).

The province of Ilam, located in the west of Iran, consists mainly of lowlands covered by arid habitats, such as deserts and semi-deserts. The area adjacent to Khuzestan province is equally a low-altitude desert with sandy hills reaching to only 100–180 m above sea level. Montane areas, between 300 and 1500 m, are found adjacent to Lorestan and Kermanshah and are rich in rocky substrata. The average annual rainfall in this area is below 700 mm. The highest summit is located in the Kabir Kuh chain in the central part of the province and reaches up to 2790 m. Three major vegetation zones can be distinguished in this area: 1 — semi-deserts, including plains and low hills with gypsum and calcareous soils, with vast desert parts dominated by *Alhagi mannifera*, *Capparis spinosa*, *Hammada salicornica*, *Prosopis farcta*, *Silybum marianum*, *Vitex pseudonegundo*, *Ziziphus nummularia*; 2 — high mountains and cushion-plant areas, mostly covered by the drought-resistant *Quercus brantii*; and 3 — shrubby parts above the *Quercus*-growing line, mostly with plant species like *Acer monspessulanum*, *Alkanna orientalis*, *Amygdalus elaeagnifolia*, *Amygdalus haussknechtii* and other herbaceous plants like *Acantholimon erinaceum*, *Acanthophyllum microcephalum*, *Artemisia haussknechtii*, *Bunium luristanicum*, *Celtis caucasica* and, *Lonicera nummulariifolia*.

Materials and methods

Lichens were identified from 14 sites within the study area (FIG. 1). The material was collected by the first author between 2004 and 2009. The principal identification guides used were Brodo et al. (2000), Hinds & Hinds (2008), and Purvis et al. (1992). TLC was performed following Orange et al. (2001) using solvent system EA and G on silica gel 60 F₂₅₄ layer 20 × 20 cm glass plates; 10% sulphuric acid was used as a reagent for the visualization of the spots. The specimens are kept in TARI with duplicates in the private herbarium of the first author and duplicates of most species in B, F and SBUH.

Localities

- I– Chaharmahal & Bakhtiyari, S of Shahrekord, between Tanghanak and Shalamzar, 32°29'N, 50°54'E, c. 1700 m, 24.1.2007.
- II– Gorgan, E of Gorgan, 36°52'N, 54°50'E, c. 900 m, 11.10.2006.
- III.1– Ilam, Dehloran, 32°41'N, 47°25'E, 1350 m, 13.4.2004.
- III.2– Ilam, Abdanan towards Dehloran, Murmuri, dry limestone and gypsum hills, 32°43'N, 47°40'E, 1875 m, 19.8.2005.
- III.3– Ilam, plains toward W slope of Dinar Kuh, montane area, 32°50'N, 46°52'E, 1065 m, 10.9.2006.
- III.4– Ilam, Abdanan, Dinar Kuh, montane area, Sarabe Bagh, 32°49'N, 04°74'E, 2370 m, 12.3.2005.
- III.5– Ilam, Abdanan to Hezar nei, Kabir Kuh, 32°57'N, 47°20'E, 2500–3100 m, 30.3.2004.
- III.6– Ilam, c. 30 km S of Salehabad, 10 km SW of Konjancham towards Shoor o Shirin, gypsum hills along Iraq border, 33°19'N, 46°12'E, 1469 m, 5.4.2006.

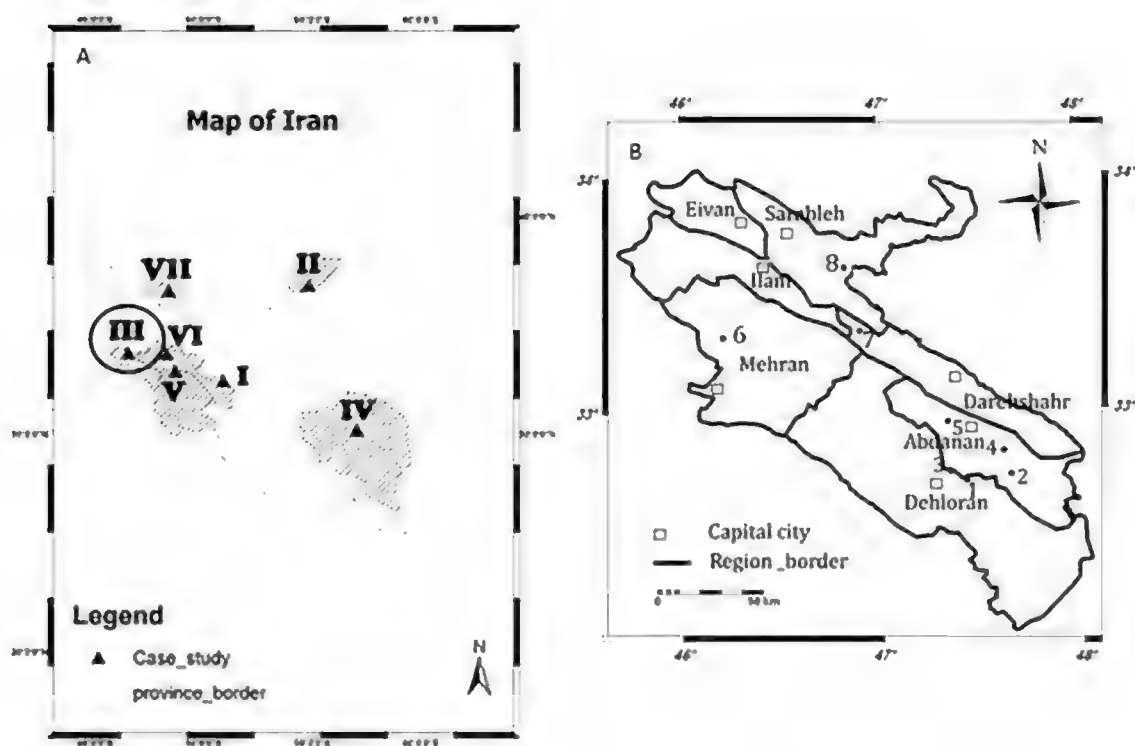


FIG. 1-A. Location of the seven provinces studied. B. Collecting sites within Ilam province (III).

III.7– Ilam, Badreh, 33°04'N, 47°19'E, 1115 m, 4.8.2005.

III.8– Ilam, S of Sarableh, Shirvan Chardavol, Chame Jangle village, Drooger, 33°34'N, 46°40'E, 900 m, 8.7.2008.

IV– Kerman, S of Kerman, 30°11'N, 57°03'E, c. 2000 m, 2.8.2007.

V– Khuzestan, Dezfull, Dez Dam, 32°56'N, 48°42'E, c. 500 m, 31.3.2008.

VI– Lorestan, S of Qal'eh Mozaffari, Kakareza, 33°43'N, 48°16'E, c. 2000 m, 14.12.2007.

VII– Zanjan, Tarom, Jamal abad, 32°62'N, 41°01'E, c. 2200 m, 15.5.2009.

List of taxa

(*: lichenicolous fungi. Roman numerals refer to the localities as listed above, and arabic numbers refer to the collection sites within Ilam province. Bold numbers are the collection numbers of T. Valadbeigi).

Acarospora laqueata Stizenb.: On siliceous rock, VI: 7071.

Acarospora nitrophila H. Magn.: On siliceous rock rich in heavy metals, on roadside, V: 7076.

Aspicilia aspera (Mereschk.) Tomin: On calcareous rock, VI: 7073.

Aspicilia determinata (H. Magn.) J.C. Wei: On calcareous rock, IV: 7061.

Aspicilia moenium (Vain.) G. Thor & Timdal: On calcareous rock, VI: 7074.

Caloplaca bohlinii H. Magn.: On calcareous rock, VI: 7075.

Candelariella coralliza (Nyl.) H. Magn.: On sandstone, III.3: 7015.

Collema nigrescens (Huds.) DC.: On the bark of *Populus nigra* and *Quercus brantii*, III.3: 7009.

Cornicularia normoerica (Gunnerus) Du Rietz: On siliceous rock, VII: 7078.

- Ingvariella bispora* (Bagl.) Guderley & Lumbsch: On siliceous rock, I: 7062.
- Lecanora albescens* (Hoffm.) Branth & Rostr.: On calcareous sandstone, III.5: 7004, and on tree bark, III.1: 7014a.
- Lecanora valesiaca* (Müll. Arg.) Stizenb.: On calcareous rock, III.3: 7037a.
- Lepraria isidiata* (Llimona) Llimona & A. Crespo: On mineral soil, III.6: 7030.
- Leptogium pulvinatum* (Hoffm.) Cromb.: On mossy calcareous soil, III.8: 7077.
- **Muellerella pygmaea* (Körb.) D. Hawksw.: On *Lecidea* sp. over calcareous rock, I: 7052a.
- Normandina pulchella* (Borrer) Nyl.: Epiphytic on bark and among mosses, III.2: 7021.
- Peltula euploca* (Ach.) Poelt: On granitic rock, III.3: 7066.
- Psora globifera* (Ach.) A. Massal.: On calcareous and mica-schist soil, III.3: 7039.
- Psora saviczii* (Tomin) Follmann & A. Crespo: On gypsiferous soil, III.5: 7002, III.7: 7019.
- Psora testacea* Hoffm.: On mosses on rock, III.4: 7017.
- Rinodina subnigra* H. Magn.: On calcareous rock, IV: 7063.
- Spiloma auratum* Sm.: On *Ulmus* sp., II: 7045. The systematic position of this species, not known in the perfect stage, is still unclear. Other species attributed to *Spiloma* have been found to belong to widely different groups like *Arthonia*, *Porpidia*, and *Xylographa*.
- Thelotrema lepadinum* (Ach.) Ach.: On *Quercus brantii* in humid site, III.5: 7005.

Acknowledgments

The authors are most grateful to Helmut Mayrhofer (Graz) for confirming the identity of *Rinodina subnigra*, to Anders Nordin (Uppsala) for confirming the identity of *Aspicilia determinata* and *A. moenium*, and to Lev Biazrov (Moscow) for sending the protologue of *Caloplaca bohlinii*. The first author also appreciates the preparation of the map by Mashaalah Mohammadpour and Valiolah Mozafaryan. The authors express their gratitude to Prof. Mark Seaward (UK) and Prof. Shirley C. Tucker (USA) for their advice and critical reading of the manuscript.

Literature cited

- Brodo IM, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. Yale University Press, New Haven, Connecticut.
- Hinds JW, Hinds PL. 2008. The Macrolichens of New England. Memoirs of the New York Botanical Garden, vol. 96. New York.
- Orange A, James PW, White FJ. 2001. Microchemical Methods for the Identification of Lichens. British Lichen Society, London.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992. The Lichen Flora of Great Britain and Ireland. Natural History Museum Publications, London.
- Seaward MRD, Sipman HJM, Schultz M, Maassoumi AA, Haji Moniry Anbaran M, Sohrabi M. 2004. A preliminary lichen checklist for Iran. Willdenowia 34: 543–576.
- Seaward MRD, Sipman HJM, Sohrabi M. 2008. A revised checklist of lichenized, lichenicolous and allied fungi for Iran. Sauteria 15: 459–520.

***Chasakopama*, a new dematiaceous hyphomycetous genus from India**

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Abstract — The novel dematiaceous hyphomycetous genus is characterized by discrete, polyblastic, denticulate conidiogenous cells, producing campanulate conidia singly with two dark band-like septa.

Key words — macronematous, sympodial, inflated, vasiform, *Chasakopama velgodensis*

The state of Andhra Pradesh, India has distinct forest types, several of which remain unexplored with regard to microfungi. The authors have been involved in the collection and systematic study of the microfungi of this region, giving special attention to the dematiaceous hyphomycetes associated with plant litter.

In one of these surveys, an interesting dematiaceous hyphomycetous fungus was found colonizing dead, unidentified twigs. Study of the fungus and perusal of literature (Ellis 1971, 1976; Matsushima 1975, 1983, 1996; Carmichael et al. 1980, Castañeda 1986, Mercado 1984, Mercado et al. 1997, Rao & de Hoog 1986) led to the conclusion that the fungus is undescribed. The fungus is characterized by macronematous or semi-macronematous conidiophores with polyblastic, discrete, inflated conidiogenous cells producing campanulate conidia with two dark band-like septa. As the fungus cannot be accommodated in any known genus, a new taxon is proposed.

***Chasakopama* Manohar., Bagyan., N.K. Rao & Kunwar, gen. nov.**

MYCOBANK MB 512920

Coloniae effusae vel discretae, atrobrunneae, hyphis ramosus, septatis, pallide brunnea quod olivaceo brunnea. Conidiophora macronemata vel semimacronemata, mononemata,

recta vel flexuosa, septatis, pallide brunnea quod olivaceo brunnea. Cellulae conidiogena polyblastica, discreta, denticulatae. Conidis solitaris, sicca, simplicis, campanulatae, brunneis quod leniterbrunnea, biseptata, horizontalea triis atris.

SPECIES TYPICA: *Chasakopama velgodensis* Manohar., Bagyan., N.K. Rao & Kunwar

ETYMOLOGY: The new genus name *Chasakopama* (Sanskrit: masculine) refers to the bell-like shape of the conidia.

Colonies effuse or discrete, dark blackish brown, slightly erumpent, hairy, mycelium immersed and superficial, immersed mycelium composed of brown to pale brown group of cells while superficial mycelium composed of branched, creeping, anastomosing, septate, pale brown to olivaceous hyphae. Conidiophores macronematous or semi-macronematous, mononematous, erect, straight or flexuous, thick walled, septate, pale brown to olivaceous brown. Conidiogenous cells polyblastic, integrated, terminal, denticulate, indeterminate, sympodial, inflated, conico-cylindrical, subspherical or irregular. Conidia solitary, campanulate, smooth, light brown, thick walled with two dark band-like transverse septa.

Chasakopama velgodensis Manohar., Bagyan., N.K. Rao & Kunwar, **sp. nov.**

MYCOBANK MB 512920

FIGS. 1–6

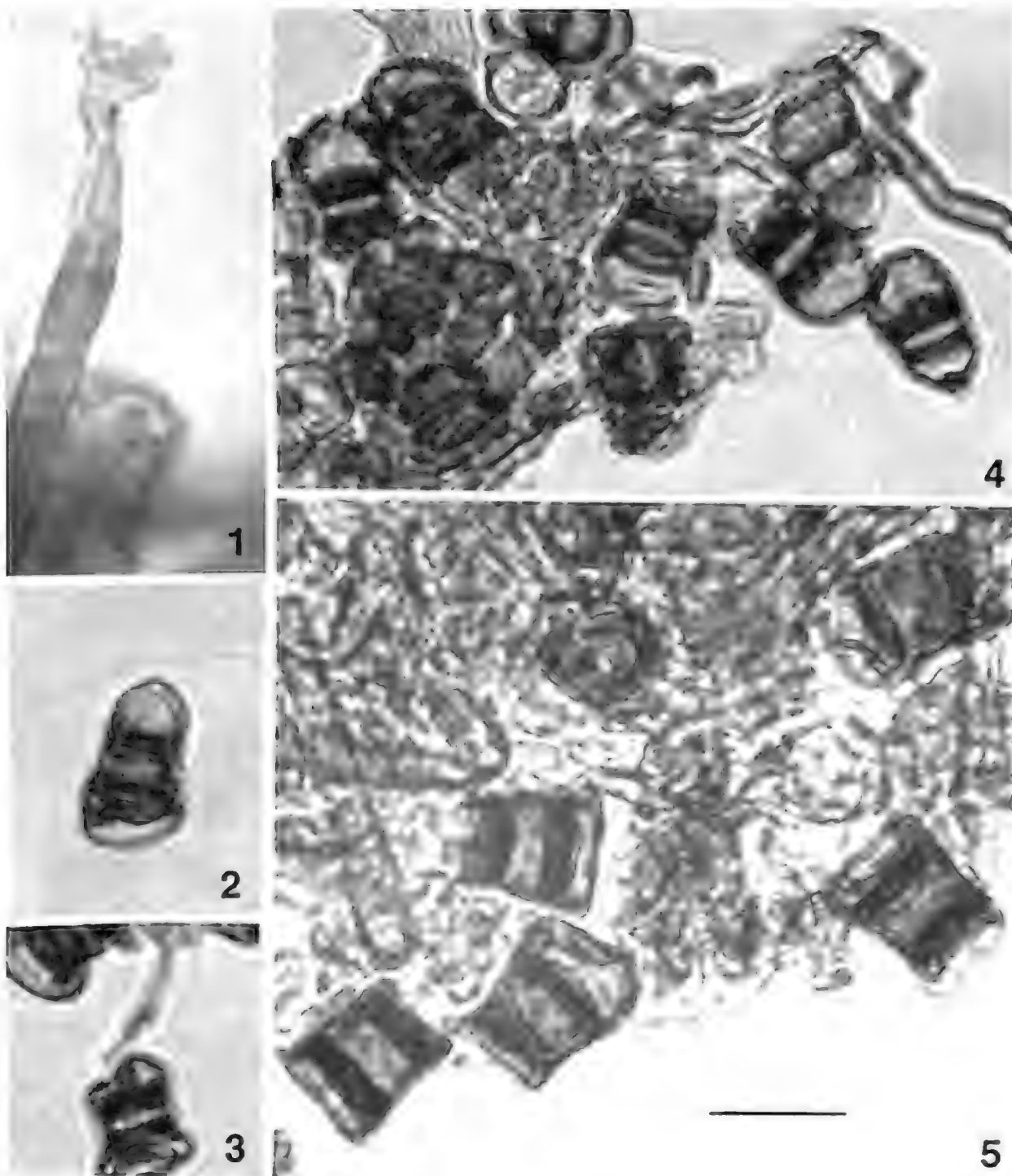
Hyphis 3–4.5 µm lata. Conidiophora 1–3 septatis, pallide brunnea quod olivaceo brunnea, usque 32 µm longis, 3–4 µm latis. Cellulae conidiogena polyblastica, discreta, denticulatae. Conidio solitaris, sicca, simplicis, campanulatae, vasiformis, laevia, membrana incrassatus, brunneis quod leniterbrunnea, biseptata, horizontalea triis, 1.5–2.5 µm crassa, conidio 11–14 µm longis, raro 18 µm, 8–10 µm lata apicalis, basim 6–8 µm lata.

HOLOTYPE: On dead, unidentified twigs, Gundlabrahmeswram, Distt. Velgod, A.P., India, 27 Nov 1984, leg. N.K. Rao, IMI 296874.

ETYMOLOGY: The specific epithet denotes the place of collection.

Colonies effuse or discrete, dark blackish brown, slightly erumpent, hairy, mycelium both immersed and superficial, immersed mycelium composed of brown to pale brown group of cells while superficial mycelium composed of branched, creeping, anastomosing, septate, pale brown, olivaceous hyphae, 3–4.5 µm thick. Conidiophores macronematous or semi-macronematous, mononematous, erect, straight or flexuous, thick walled, smooth, pale brown to olivaceous brown, 1–3 septate, up to 32 µm long, 3–4 µm wide. Conidiogenous cells polyblastic, integrated, denticulate, indeterminate, conico-cylindrical, inflated, subspherical, or irregular. Conidia solitary, campanulate, smooth, light brown, thick walled with two dark band-like transverse septa, 1.5–2.5 µm thick, conidia 11–14 µm long, rarely up to 18 µm long, 8–10 µm wide at the apex, 6–8 µm wide at the base.

The fungus described above shows superficial resemblance with the genus *Colemaniella* Agnihothr. (Agnihothrudu 1974) but differs from it in



FIGS. 1–5. *Chasakopama velgodensis*. 1. Part of conidiophore with denticulate conidiogenous cell. 2–5. Conidia. 1, 5 Bar = 10 μ m; 2–4. Bar = 12 μ m.

conidiogenesis and the presence of transverse septa. It also resembles to some extent in conidial shape with *Spadicoides subramanianii* Bhat (Bhat 1985) but the conidiogenous cells are discrete in the present fungus while in *Spadicoides* S. Hughes, they are integrated. The fungus shows some unique characters like polyblastic, discrete, denticulate, inflated conidiogenous cells; campanulate, conidia with two dark, band-like septa. We have found no satisfactory placement for this fungus among the described genera known, and thus necessitating erection of the new genus.

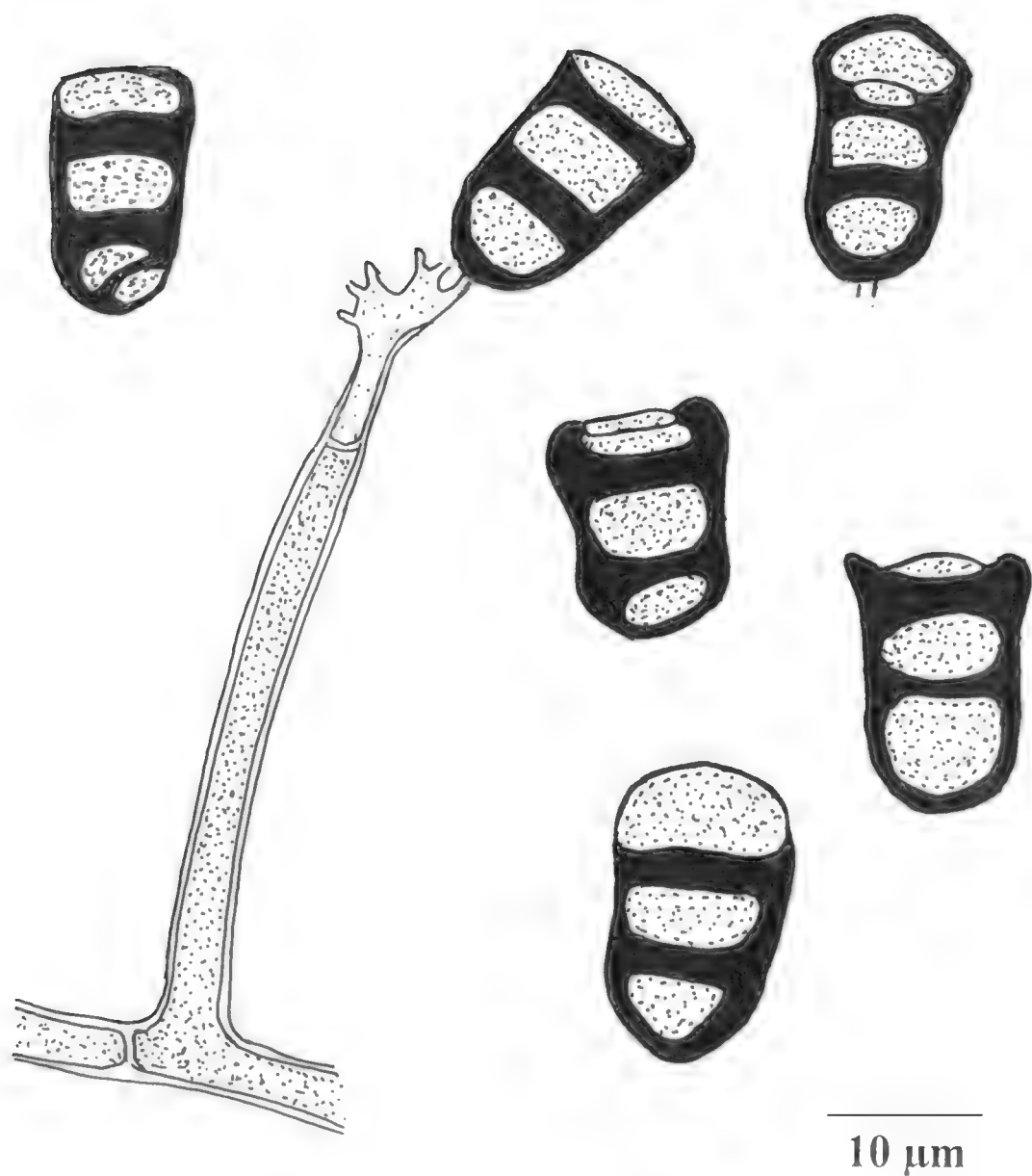


FIG. 6. Conidiophore, conidiogenous cell and conidia of *Chasakopama velgodensis*.

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Literature cited

Agnihotrudu V. 1974. *Colemaniella*. J. Coffee Res. 4(1): 3–6.
Bhat DJ. 1985. Two new hyphomycetes from Ethiopia. Proc. Indian Acad. Sci. 94: 269–272.

- Carmichael JW, Kendrick WB, Connors LL, Sigler L. 1980. Genera of *Hyphomycetes*. Univ. of Alberta Press, Edmonton. 386 pp.
- Castañeda Ruiz RF. 1986. Deuteromycotina de Cuba Hyphomycetes – IV. Academia de Ciencias de Cuba. 17 pp.
- Ellis MB. 1971. Dematiaceous hyphomycetes. CMI, Kew, UK. 608 pp.
- Ellis MB. 1976. More dematiaceous hyphomycetes. CMI, Kew, UK. 507 pp.
- Matsushima T. 1975. Icones microfungorum, a Matsushima lectorum, Publ. by the author, Kobe, Japan. 209 pp.
- Matsushima T. 1983. Matsushima Mycological Memoirs. 3: 1–90.
- Matsushima T. 1996. Matsushima Mycological Memoirs. 9: 1–40.
- Mercado Sierra Á. 1984. Hifomicetes Demaciáceos de Sierra del Rosario, Cuba, La Habana, Cuba: Editorial Academia. 181 pp.
- Mercado Sierra Á, Holubova-Jechova C, Mena Portales J. 1997. Hifomicetes Demaciáceos de Cuba. Enteroblásticos, Museo Regionale di Scienze Naturali, Torino. 388 pp.
- Rao V, de Hoog GS. 1986. New or critical hyphomycetes from India. Studies in Mycol. 28: 1-84.

New Brazilian species of *Canoparmelia* with medullary olivetoric, anziaic, and sekikaic complexes

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Abstract — *Canoparmelia consanguinea*, *C. roseoreagens*, and *C. subroseoreagens* are described as new. The occurrence of *C. sanguinea* is confirmed for Rio Grande do Sul State, 1000 km south of the type locality. These species all exhibit a C+ rose medullary reaction but differ in their secondary metabolites and vegetative propagules, among other aspects.

Key words — *Parmeliaceae*, *Canoparmelia texana*

Introduction

Canoparmelia, which was proposed by Elix et al. (1986) as a segregate of *Pseudoparmelia* Lynge (Hale 1976), included 28 species characterized by the absence of cilia, a black or brown lower surface, a narrow marginal zone paler than the center, and typically bifusiform or (more rarely) cylindrical or weakly fusiform conidia.

Sixteen years later, Nash & Elix (2002) referred 45 species to this genus, five producing medullary compounds that react C+ rose but none reported for Brazil. However, recently Benatti et al. (2009) described *C. sanguinea*, a C+ species from southeastern Brazil.

Spielmann (2006) reported eight *Canoparmelia* species for Rio Grande do Sul State, species previously recorded by Marcelli (2004) as occurring in Brazil. During a lichen survey in the Municipality of Vacaria, Rio Grande do Sul State, four (three new) species *Canoparmelia* were collected that exhibited a C+ rose medullary reaction.

Material and methods

Morphological features were studied under a stereomicroscope and anatomical sections of the apothecia and pycnidia were made with a razor blade. Spot tests were performed with potassium hydroxide (K), sodium hypochlorite (C) and para-phenylenediamine (P) and the thallus examined under UV light. Lichen substances were detected by thin-layer chromatography (TLC) using solvent C (Huneck & Yoshimura 1996) and high performance liquid chromatography (HPLC) (Elix et al. 2003).

Results and discussion

The three new species described below produce a unique cohort of medullary substances that include olivetoric, anziaic and sekikaic derivatives that are responsible for the C+ rose reaction of the medulla. Apart from *C. sanguinea*, all other *Canoparmelia* species with a C+ rose medulla contain either lecanoric or gyrophoric acid. A key to the described *Canoparmelia* species diagnosed by a C+ rose medulla is presented below (“*” indicates species not cited in the text).

Key for *Canoparmelia* species with C+ rose medulla

- 1a. Lower surface brown. *C. amabilis**
- 1b. Lower surface black 2
- 2a. Soredia and isidia absent 3
- 2b. Soredia or isidia present. 4
- 3a. Yellow K+ purple pigment in the medulla. *C. corrugativa**
- 3b. Yellow K+ purple pigment absent, medulla uniformly white *C. norpruinata**
- 4a. Soredia present; isidia absent. 5
- 4b. Isidia present; soredia absent. 6
- 5a. Soredia originating directly from the upper surface *C. consanguinea*
- 5b. Soredia originating mostly from the border of “schizidia-like” plaques
. *C. subroseoreagens*
- 6a. Isidia conspicuously inflated *C. rarotongensis*
- 6b. Isidia cylindrical 7
- 7a. Isidia initially papillate, then cylindrical to thickened; upper surface rugose
towards the center; gyrophoric acid present. *C. martinicana*
- 7b. Isidia cylindrical, not thickened; upper surface smooth to cracked;
gyrophoric acid absent. 8
- 8a. Isidia simple to slightly ramified; with substances of the anziaic, divaricatic,
glomelliferic, and perlatolic acid complex. *C. sanguinea*
- 8b. Isidia mostly coralloid, with methyl divarinolcarboxylate and unknown
depsides *C. roseoreagens*

The new species

Canoparmelia consanguinea Marcelli, Canêz & Elix, sp. nov.

FIG. 1a

MYCOBANK MB 515127

DIAGNOSIS: *Similis* *Canoparmelia sanguinea* *substantiis medullae sed soledibus granularibus differt.*

HOLOTYPE—Brazil, Rio Grande do Sul State, Municipality of Vacaria, Fazenda da Estrela locality, open field, 28°04'01.8"S, 50°57'45.4"W, 920 m alt., on basaltic rock, col. L.S. Canêz & A.A. Spielmann 892, 13-I-2003 (SP).

THALLUS greenish gray (buff in herbarium), lobate to sublaciniate, to 8.5 cm wide. LOBES irregularly branched, (0.8–)1.6–3.0 mm wide, loosely adnate, contiguous, slightly overlapping, apices rounded, margin smooth to crenate, plane to involute, sometimes slightly elevated at the apices; surface continuous to slightly irregularly cracked in the center, smooth, shiny. LACINULAE and PUSTULAE absent. MACULAE reticulate, evident on the distal areas. SORALIA orbicular, laminal and marginal, blackish when old; SOREDIA granular, persistent, agglutinated, soon forming corticate granules which may develop into irregular pseudoisidia or small lobules in the older parts of the thallus. MEDULLA white, K+ purple pigment absent. LOWER SURFACE black, dull to a little shiny, papillate, smooth in some parts; MARGINAL ZONE brown, 0.9–2.5 mm wide, smooth to papillate, rarely rugose; RHIZINES black, some with whitish apices, simple to penicillate, $0.20\text{--}1.25 \times 0.05\text{--}0.10$ mm, dense to frequent. APOTHECIA very rare, plane, adnate, submarginal, imperforate, 2.7 mm diam.; margin smooth to solediate, amphithecium solediate. ASCOSPORES ellipsoid, $10.0\text{--}12.5 \times 5.0\text{--}6.0$ μm , epispore 1.0 μm wide. PYCNIDIA submarginal, ostiole black, immature; CONIDIA not seen.

SPOT TESTS: cortex K+ yellow, UV–; medulla K– (milky), C+ rose, KC+ rose, P+ pale yellow, UV+ pale blue.

TLC/HPLC: Atranorin (\pm trace), olivetolcarboxylic acid (major), decarboxynorstenosporic acid (major), 4-O-demethylstenosporic acid (major), divaricatinic acid (minor), decarboxyanziaic acid (trace), decarboxystenosporic acid (minor), perlatolic acid (minor), decarboxyperlatolic acid (minor), depsidellin B (minor), depsidellin C (minor), divaricatic acid (minor or trace), subdivaricatic acid (trace), norsubdivaricatic acid (trace).

COMMENTS—*Canoparmelia consanguinea* is characterized by orbicular soralia, a C+ rose medullary reaction, and a complex medullary chemistry. In addition, this species has granular soledia, which often form corticate granules that may develop into irregular pseudoisidia or lobules.

Canoparmelia consanguinea is morphologically similar to *C. sanguinea*, which also reacts C+ red (hence the name) and produces a very similar cohort of lichen acids, namely olivetolcarboxylic acid (minor), 4-O-

methylolivitolcarboxylic acid (minor), glomelliferic acid (minor/absent), glomellin (trace/minor), decarboxyanziaic acid (major), decarboxystenoporic acid (minor), decarboxyperlatolic acid (minor), divaricatinic acid (minor), depsidellin B (minor), unknowns (minor) (Benatti et al. 2009). However, *C. sanguinea* has true isidia rather than soredia.

The new species *C. subroseoreagens* (described below) also produces soredia and reacts C+ rose but has a different chemistry, a peculiar upper surface, and a very unique means of producing soredia.

In the field, *C. consanguinea* might be confused with *C. texana* (Tuck.) Elix & Hale, a very abundant lichen in Brazil, since both species have orbicular soralia. However, *C. texana* has a much simpler chemistry, producing only divaricatic acid (C–, KC+ purplish) in the medulla.

***Canoparmelia roseoreagens* Marcelli, Canêz & Elix, sp. nov.**

FIG. 1b

MYCOBANK MB 515128

DIAGNOSIS: *Similis* *Canoparmelia sanguinea* medulla C+ rosa et praesentia isidiorum sed substantiis medullae differt.

HOLOTYPE—Brazil, Rio Grande do Sul State, Municipality of Vacaria, Fazenda da Estrela locality, *Araucaria angustifolia* forest, 28°03'58,8"S, 50°57'34,1"W, 905 m alt., on tree bark, leg. L.S. Canêz & A.A. Spielmann 96, 03-III-2003 (SP, isotype in H).

THALLUS grayish, sublaciniate, to 9.0 cm wide. SUBLACINIAE irregularly branched, 0.9–2.5 wide, adnate, contiguous, apices truncate, margin smooth to crenate; upper surface smooth, continuous to slightly cracked in the center of the thallus; MACULAE weak or absent, reticulate, more evident in the young parts, sometimes forming small cracks. LACINULES, PUSTULES and SOREDIA absent. ISIDIA concolorous with the thallus, cylindrical, simple to mostly coralloid when mature, 0.10–0.45 × 0.05 mm, erect, firm, laminal, apices eciliate, brown. MEDULLA white, K+ purple pigment absent. LOWER SURFACE black to dark brown, slightly shiny, rugose; MARGINAL ZONE brown, shiny, 0.5–1.5 mm wide, rugose, rarely papillate; RHIZINES white, dark brown or rarely black, simple to furcate, 0.25–0.50 × 0.05–0.08 mm, few to frequent, almost evenly distributed. APOTHECIA and PYCNIDIA not seen.

SPOT TESTS: cortex K+ yellow, UV–; medulla K–, C+ rose, KC+ rose, P+ pale yellow, UV–.

TLC/HPLC: Atranorin (±minor), methyl olivetolcarboxylate (major), methyl divarinolcarboxylate (major), eight major unknown depsides (derivatives of norsekikaic acid, norhomosekikaic acid and norhyperhomosekikaic acids or their corresponding methyl esters).

COMMENTS— *Canoparmelia roseoreagens* is a maculate, isidiate species with a rugose lower surface and a complex medullary chemistry. This species is

probably the isidiate counterpart of the sorediate *C. subroseoreagens* (see below).

Another isidiate species that also has a C+ rose medulla is *C. sanguinea*, but the latter has a different chemistry, which includes substances of the anziaic, divaricatinic, glomelliferic, and perlatolic acid complexes as well depsidellin B, substances that are absent from *C. roseoreagens*. Additionally, the isidia of *C. roseoreagens* are more densely branched (mostly coralloid) than those found in the specimens of *C. sanguinea* (simple to sparsely branched) from various localities in Brazil (see below).

Two other C+ rose isidiate *Canoparmelia* species contain different medullary substances. *C. rarotongensis* Louwhoff & Elix (2000) from the Cook Islands has inflated isidia and produces lecanoric acid, orsellinic acid, and orcinol, while *C. martinicana* (Nyl.) Elix & Hale (from North America and northern South America), has papillate, then cylindrical to thickened, isidia and produces gyrophoric acid, protocetraric acid, and (rarely) norlobaridone (Hale 1976).

In the field, *C. roseoreagens* could be confused with *C. caroliniana* (Nyl.) Elix & Hale, which is very abundant in Brazil. *Canoparmelia caroliniana*, which may have similar isidia and maculation, has a paler grayish-white upper surface and different chemistry, producing perlatolic acid (major), stenosporic acid (major), glomelliferic acid (minor), anziaic acid (trace), 4-O-demethylstenosporic acid (trace), divaricatic acid (trace) in the medulla (C–, KC+ faint purple).

***Canoparmelia subroseoreagens* Canêz, Marcelli & Elix, sp. nov.**

FIG. 1c

MYCOBANK MB 515129

DIAGNOSIS: *Similis* *Canoparmelia roseoreagens* *substantiis medullae sed praesentia soredium granularium differt.*

HOLOTYPE—Brazil, Rio Grande do Sul State, Municipality of Vacaria, Fazenda da Estrela locality, *Araucaria angustifolia* forest, 28°03'58.8"S, 50°57'34.1"W, 905 m alt., on tree bark, leg. L.S. Canêz & A.A. Spielmann 1374, 03-III-2003 (SP, isotype in H).

THALLUS grayish, sublaciniate to laciniate, to 6.0 cm wide; LACINIAE irregularly branched, smooth, plane, adnate, contiguous, 0.5–2.5 mm wide, apices truncate, margin slightly crenate to sinuous, black, surface continuous only in the younger parts, becoming markedly cracked and even forming "schizidia like" plaques in the center of the thallus. MACULAE weak, reticulate, present at the apices of the lobes. LACINULAE, PUSTULAE and ISIDIA absent. SORALIA orbicular, mainly laminal, less frequently marginal; SOREDIA laminal, mostly subgranular, originating mainly from the margins of cracks; granules ±becoming corticate and/or forming small pseudoisidia. MEDULLA white, K+ purple pigment absent. LOWER SURFACE black, shiny, papillate; MARGINAL ZONE dark brown, opaque to shiny, 0.7–2.0 mm wide, smooth to papillate; RHIZINES black, rarely

with whitish apices, simple, $0.20\text{--}0.85 \times 0.05$ mm, frequent to abundant, evenly distributed. APOTHECIA and PYCNIDIA not seen.

SPOT TESTS: upper cortex K+ yellow, UV–; medulla K–, C+ purplish rose, KC+ strongly rose evanescent, P–, UV–.

TLC/HPLC: Atranorin (\pm trace) olivetolcarboxylic acid (major), twelve major unknown depsides (derivatives of norsekikaic acid, norhomosekikaic acid and norhyperhomosekikaic acid).

COMMENTS– *Canoparmelia subroseoreagens* is characterized by a strongly cracked upper surface, with most soredia originating from the somewhat elevated crack margins to form rounded hollowed structures that resemble open pustules. This species has additionally a unique chemistry, producing olivetolcarboxylic acid (C+ rose) as main medullary substance together with numerous unknown *meta*-depsides.

It is chemically and morphologically related to *C. roseoreagens* described above, but that species produces isidia rather than soredia. The specific epithet refers to this similarity.

A further sorediate C+ species is *C. consanguinea* described above, but that species differs in chemistry and in producing soredia directly from the upper surface, rather than from the border of plaques.

Species new to Rio Grande do Sul

Canoparmelia sanguinea Marcelli, Benatti & Elix, Mycotaxon 106: 436 (2009)

Canoparmelia sanguinea is characterized by a thallus with a C+ rose medullary reaction associated with simple to sparsely branched isidia. The complex medullary chemistry includes olivetolcarboxylic acid (minor), 4-O-methylolivetolcarboxylic acid (minor), \pm glomelliferic acid (minor), glomellin (trace/minor), decarboxyanziaic acid (major), decarboxystenosporic acid (minor), decarboxyperlatolic acid (minor), divaricatinic acid (minor), depsidellin B (minor), unknowns (minor) (Benatti et al. 2009).

SPECIMENS EXAMINED—**Brazil**. Rio Grande do Sul State: Municipality of Vacaria, Fazenda da Estrela locality, gallery forest, $28^{\circ}02'41''\text{S}$, $50^{\circ}56'52,3''\text{W}$, 800 m alt., on bark of isolated tree in field near right margin of stream, leg. L.S. Canêz & A.A. Spielmann 793, 795, 798, 12-I-2004 (SP); São Paulo State, Municipality of Mairiporã, Cantareira Range, on a tree trunk felled during village construction, 03-XI-1989, leg. M.P. Marcelli 6029 (Holotype SP!).

The specimens from Rio Grande do Sul closely resemble the holotype (SP!) except for having a paler colored thallus, more imbricate lobes with somewhat involute lateral margins and by producing traces of anziaic and stenosporic acids in addition to the acids found in the specimens from São Paulo (including the holotype).

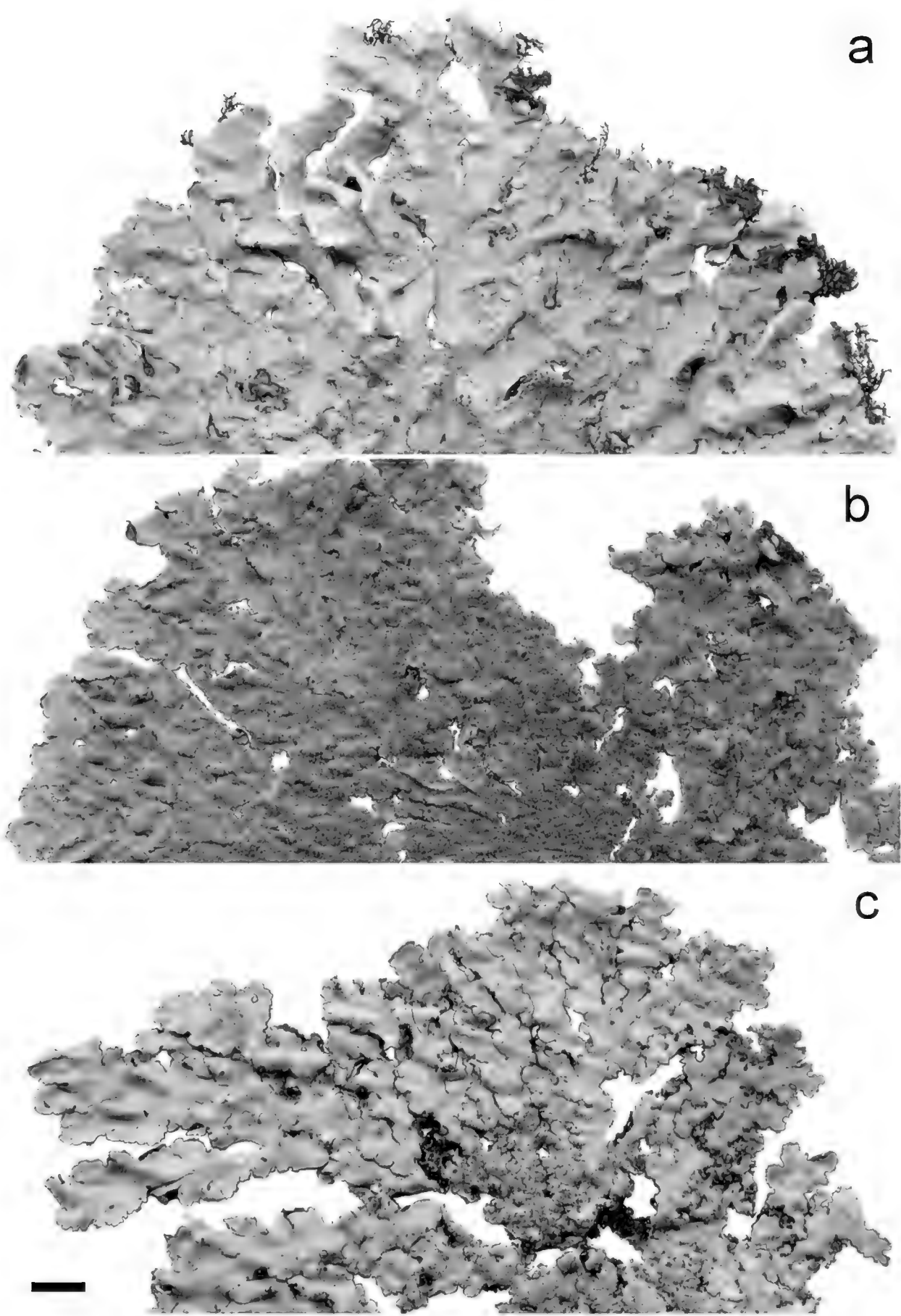


FIGURE 1a–c. Partial new species holotypes
a. *Canoparmelia consanguinea*; b. *C. roseoreagens*; c. *C. subroseoreagens*

All material was collected in rainforest areas at elevations of 800–900 m, but the Rio Grande do Sul and São Paulo localities are nearly 1000 km apart, considerably extending the known distribution of this species.

Acknowledgements

The authors wish to thank Dr. Thomas Nash III and Dr. André Aptroot for critical revision of the manuscript. This work was supported by a CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) masters grant to L.S. Canêz, and for CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) research support to M.P. Marcelli.

Literature cited

- Benatti MN, Marcelli MP, Elix JA. 2009 ("2008"). *Canoparmelia sanguinea*, a new *Parmeliaceae* from Brazil. *Mycotaxon* 106:435–439.
- Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. *Bibliotheca Lichenologica* 86: 1–7.
- Elix JA, Johnston J, Verdon D. 1986. *Canoparmelia*, *Paraparmelia* and *Relicinopsis*, three new genera in the *Parmeliaceae* (Lichenized *Ascomycotina*). *Mycotaxon* 27: 271–282.
- Hale ME. 1976. A monograph of the lichen genus *Pseudoparmelia* Lynge (*Parmeliaceae*). *Smithsonian Contributions to Botany* 31: 1–62, 18 fig.
- Huneck S, Yoshimura I. 1996. Identification of lichen substances. Springer. Berlin. 493p.
- Louwhoff SHJJ, Elix JA. 2000. The lichens of Rarotonga, Cook Islands, South Pacific Ocean II: *Parmeliaceae*. *Lichenologist* 32: 49–55.
- Marcelli MP. 2004. Checklist of lichens and lichenicolous fungi of Brazil. Version 1: June 2004. http://www.biologie.uni-hamburg.de/checklists/brazil_l.htm. Accessed 2004, December.
- Nash III TH, Elix JA. 2002. *Canoparmelia*. In: Nash III TH, Ryan BD, Gries C, Bungartz F. (eds.). *Lichen Flora of the greater Sonoran Desert Region*. Vol. 1. Arizona State University, Tempe, Arizona, USA. pp. 122–125.
- Spielmann AA. 2006. Checklist of lichens and lichenicolous fungi of Rio Grande do Sul (Brazil). *Caderno de Pesquisas Série Biologia* 18(2): 7–125.

***Cyberlindnera*, a replacement name for *Lindnera* Kurtzman et al., nom. illegit.**

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Abstract — The fungal genus *Lindnera* is a later homonym of a validly published plant genus. *Cyberlindnera* is introduced as a replacement name, with 21 new combinations.

Key words — nomenclature, yeast

The fungal genus *Lindnera* Kurtzman et al. 2008 (*Saccharomycetales* incertae sedis) is a later homonym of the validly published plant genus *Lindnera* Fuss 1866 (*Tiliaceae*) and is thus a nom. illegit. (ICBN [Vienna Code] Art. 53.1). The generic name *Cyberlindnera* is introduced here with twenty-one new combinations as replacements for the illegitimate name and the specific epithets combined with it.

***Cyberlindnera* Minter, nom. nov.**

INDEXFUNGORUM 534376

Lindnera Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 949, 2008, NOM. ILLEGIT.

***Cyberlindnera americana* (Wick.) Minter, comb. nov.**

INDEXFUNGORUM 534377

Hansenula bimundalis var. *americana* Wick., Mycopathologia et Mycologia Applicata 26(1): 97, 1965. [BASIONYM]

Lindnera americana (Wick.) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera amylophila* (Kurtzman, M.J. Smiley, C.J. Johnson, Wick. & Fuson) Minter, comb. nov.**

INDEXFUNGORUM 534378

Pichia amylophila Kurtzman, M.J. Smiley, C.J. Johnson, Wick. & Fuson, International Journal of Systematic Bacteriology 30(1): 209, 1980. [BASIONYM]

Lindnera amylophila (Kurtzman, M.J. Smiley, C.J. Johnson, Wick. & Fuson) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

Cyberlindnera bimundalis (Wick. & Santa María) Minter, **comb. nov.**

INDEXFUNGORUM 534379

Hansenula bimundalis Wick. & Santa María, Mycopathologia et Mycologia Applicata 26(1): 96, 1965. [BASIONYM]

Lindnera bimundalis (Wick. & Santa María) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

Cyberlindnera euphorbiae (Van der Walt & A. Opperman) Minter, **comb. nov.**

INDEXFUNGORUM 534380

Pichia euphorbiae Van der Walt & A. Opperman, Antonie van Leeuwenhoek 49(1): 55, 1983. [BASIONYM]

Lindnera euphorbiae (Van der Walt & A. Opperman) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

Cyberlindnera euphorbiiphila (Van der Walt) Minter, **comb. nov.**

INDEXFUNGORUM 534381

Hansenula euphorbiiphila Van der Walt, Antonie van Leeuwenhoek 48(5): 467, 1982. [BASIONYM]

Lindnera euphorbiiphila (Van der Walt) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

Cyberlindnera fabianii (Wick.) Minter, **comb. nov.**

INDEXFUNGORUM 534382

Hansenula fabianii Wick., Mycopathologia et Mycologia Applicata 26(1): 84, 1965. [BASIONYM]

Lindnera fabianii (Wick.) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

Cyberlindnera jadinii (Sartory, R. Sartory, Weill & J. Mey.) Minter, **comb. nov.**

INDEXFUNGORUM 534383

Saccharomyces jadinii Sartory, R. Sartory, Weill & J. Mey., Comptes Rendus Hebdomadaire des Séances de l'Académie des Sciences, Paris, Série D Sciences Naturelles 194: 1688, 1932. [BASIONYM]

Lindnera jadinii (Sartory, R. Sartory, Weill & J. Mey.) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

Cyberlindnera japonica (Kurtzman) Minter, **comb. nov.**

INDEXFUNGORUM 534384

Pichia japonica Kurtzman, Mycologia 79(3): 413, 1987. [BASIONYM]

Lindnera japonica (Kurtzman) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

Cyberlindnera lachancei (Phaff, Starmer & Kurtzman) Minter, **comb. nov.**

INDEXFUNGORUM 534385

Pichia lachancei Phaff, Starmer & Kurtzman, International Journal of Systematic Bacteriology 49(3): 1296, 1999. [BASIONYM]

Lindnera lachancei (Phaff, Starmer & Kurtzman) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera macluræ* (Kurtzman) Minter, comb. nov.**

INDEXFUNGORUM 534386

Pichia macluræ Kurtzman, International Journal of Systematic and Evolutionary Microbiology 50(1): 398, 2000. [BASIONYM]

Lindnera macluræ (Kurtzman) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera meyeræ* (Van der Walt) Minter, comb. nov.**

INDEXFUNGORUM 534387

Pichia meyeræ Van der Walt, Antonie van Leeuwenhoek 48(4): 385, 1982.
[BASIONYM]

Lindnera meyeræ (Van der Walt) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera mississippiensis* (Kurtzman, M.J. Smiley, C.J. Johnson, Wick. & Fuson) Minter, comb. nov.**

INDEXFUNGORUM 534388

Pichia mississippiensis Kurtzman, M.J. Smiley, C.J. Johnson, Wick. & Fuson, International Journal of Systematic Bacteriology 30(1): 212, 1980. [BASIONYM]

Lindnera mississippiensis (Kurtzman, M.J. Smiley, C.J. Johnson, Wick. & Fuson) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera misumaiensis* (Y. Sasaki & Tak. Yoshida ex Kurtzman) Minter, comb. nov.**

INDEXFUNGORUM 534389

Pichia misumaiensis Y. Sasaki & Tak. Yoshida ex Kurtzman, International Journal of Systematic and Evolutionary Microbiology 50(1): 399, 2000. [BASIONYM]

Lindnera misumaiensis (Y. Sasaki & Tak. Yoshida ex Kurtzman) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera mrakii* (Wick.) Minter, comb. nov.**

INDEXFUNGORUM 534390

Hansenula mrakii Wick., Technical Bulletin. US Department of Agriculture 1029: 40, 1951. [BASIONYM]

Lindnera mrakii (Wick.) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera petersonii* (Wick.) Minter, comb. nov.**

INDEXFUNGORUM 534391

Hansenula petersonii Wick., Mycologia 56(3): 404, 1964. [BASIONYM]

Lindnera petersonii (Wick.) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera rhodanensis* (C. Ramírez & Boidin) Minter, comb. nov.**

INDEXFUNGORUM 534392

Saccharomyces rhodanensis C. Ramírez & Boidin, Revue de Mycologie, Paris 18: 152, 1953. [BASIONYM]

Lindnera rhodanensis (C. Ramírez & Boidin) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera sargentensis* (Wick. & Kurtzman) Minter, comb. nov.**

INDEXFUNGORUM 534393

Pichia sargentensis Wick. & Kurtzman, Mycologia 63(5): 1016, 1971. [BASIONYM]

Lindnera sargentensis (Wick. & Kurtzman) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera saturnus* (Klöcker) Minter, comb. nov.**

INDEXFUNGORUM 534394

Saccharomyces saturnus Klöcker, Zentralblatt für Bakteriologie und Parasitenkunde Abt. II 8: 129, 1902. [BASIONYM]

Lindnera saturnus (Klöcker) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 950, 2008.

***Cyberlindnera suaveolens* (Klöcker) Minter, comb. nov.**

INDEXFUNGORUM 534395

Pichia suaveolens Klöcker, Zentralblatt für Bakteriologie und Parasitenkunde Abt. II 35: 371, 1912. [BASIONYM]

Lindnera suaveolens (Klöcker) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 951, 2008.

***Cyberlindnera subsufficiens* (Wick.) Minter, comb. nov.**

INDEXFUNGORUM 534396

Hansenula saturnus var. *subsufficiens* Wick., Mycopathologia et Mycolia Applicata 37: 30, 1969. [BASIONYM]

Lindnera subsufficiens (Wick.) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 951, 2008.

***Cyberlindnera veronae* (K. Kodama) Minter, comb. nov.**

INDEXFUNGORUM 534397

Pichia veronae K. Kodama, Journal of Fermentation Technology, Osaka 52(9): 612, 1974. [BASIONYM]

Lindnera veronae (K. Kodama) Kurtzman, Robnett & Basehoar-Powers, FEMS Yeast Research 8(6): 951, 2008.

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***Strelitziana mali*, a new species causing sooty blotch on apple fruit**

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Abstract — *Strelitziana mali*, a new species isolated from the cuticle of apple fruit (*Malus ×domestica*), is described and illustrated. Samples were collected from two orchards in Shaanxi and Henan Provinces, China. The fungus, pathogenic to apple fruits, is distinguished from the other known species in the genus both by morphological characters visible using optical and scanning electron microscopes and by phylogenetic analysis based on ITS sequences.

Key words — *Chaetothyriales*, internal transcribed spacer, scanning electron microscopy

Introduction

The genus *Strelitziana* Arzanlou & Crous (2006) was named after the host genus, *Strelitzia*, from which the type species was collected as a member of *Chaetothyriales*. Features include conidiophores that are erect, solitary, subcylindrical, straight to geniculous-sinuous, pale brown and arise from aerial and submerged mycelia; conidiogenous cells that are terminal, integrated, rejuvenate percurrently, and proliferate apically via several short, conspicuous denticles; rhexolytic conidiogenesis; conidia that are pale brown, smooth, long obclavate, and multi-euseptate; and microcyclic conidiation in culture.

The genus was established to accommodate *Strelitziana africana* Arzanlou & Crous (Arzanlou et al. 2006) collected from leaves of *Strelitzia* sp. in Africa. Recently, during investigations of sooty blotch and flyspeck of apple in China, four isolates were found that appeared to be closely related to *Strelitziana*.

*Corresponding author.

They are described as a new species of *Strelitziana* based on morphological comparison, observation with scanning electron microscope and by ITS sequence analysis.

Materials and methods

ISOLATES. Apples were collected from Yangling and Qianxian in Shaanxi Province, and Zhengzhou in Henan Province. Thalli were transferred from colonies on the apple surface to a potato dextrose agar (PDA) slant and cultured at 25°C in darkness (Sun et al. 2003). One-month-old cultures on PDA were described and photographed. Then 1-month-old pure cultures were transferred to fresh PDA plates, a sterile cover slip was partially inserted into the agar adjacent to the colony, angled away from the colony at approximately 60 degrees to the agar surface, in order to enable the fungus to grow onto the cover slip.

SCANNING ELECTRON MICROSCOPY. For scanning electron microscopy (SEM), cover slips with attached hyphae were fixed in 3% glutaraldehyde and 1% osmium tetroxide in 0.1 M cacodylate buffer, pH 6.8. After dehydration in a series of ethanol rinses, the hyphae were dehydrated in a critical point drier, sputter-coated with gold, and examined under a scanning electron microscope (Joel JSM 6360LV) at accelerating voltages of 15 and 25 KV.

DNA SEQUENCING. Template DNA was extracted from fungal mycelium according to the method of Barnes et al. (2001), and primer pairs used for amplification and sequencing of the ITS region were ITS1-F (Gardes et al. 1993) and ITS4 (White et al. 1990). Amplification was completed with the following cycling parameters: initial denaturation at 94°C for 3 min followed by 25 cycles of denaturation at 94°C for 30 s, annealing at 52°C for 30 s, and extension at 72°C for 10 min. The PCR products were sequenced by Organism Technology Co., Ltd., Shanghai, China.

One sequence was compared to the GenBank NR database, and target sequences with high similarity were downloaded. Preliminary alignments with downloaded sequences and those obtained in this study were performed using CLUSTAL-X (Thompson et al. 1997). The alignments were imported into BioEdit 5.0.9.1 (Hall 1999) and manually adjusted. Phylogenetic analysis of aligned DNA sequences was performed with PAUP version 4.0b10 for 32-bit Microsoft Windows (Swofford 2001). Heuristic searches were performed with 1000 random sequence additions. Clade stability was evaluated by bootstrap analysis using 1000 replications. Other measures calculated for parsimony analyses included tree length, consistency index, retention index, and rescaled consistency index (CI, RI and RC, respectively). *Pseudocercospora syzygiicola* was used as the outgroup taxon.

Results

Four isolates (YL12, YL06, QX01, ZZ21) were obtained from the apple fruit cuticle. The sequences were deposited in GenBank (QX01 = FJ917556, YL06 = FJ917557, YL12 = FJ917558, ZZ21 = FJ917559). The ribosomal DNA ITS region (ITS1, 5.8S rDNA gene, ITS2) was sequenced for each isolate, and

TABLE 1. Sequences used in the phylogenetic analysis

SPECIES	GENBANK	REFERENCE
<i>Capronia acutiset</i> a	AF050241	Untereiner et al. 1999
<i>C. fungicola</i>	AF050246	Untereiner et al. 1999
<i>C. nigerrima</i>	AF050251	Untereiner et al. 1999
<i>C. pulcherrima</i>	AF050256	Untereiner et al. 1999
<i>Cladophialophora devriesii</i>	AB091212	Abliz et al. 2003
<i>Cladophialophora</i> sp.	EU137326	de Hoog et al. 2007
<i>Coniosporium</i> sp.	AM279681	Sert et al. 2007
<i>Cyphellophora hylomeconis</i>	EU035415	Crous et al. 2007
<i>Exophiala attenuata</i>	EF025392	Zeng et al. 2007
<i>Heteroconium kleinzii</i> ense	EF110616	Crous et al. 2007
<i>H. tritici</i> cola	AJ748260	Kwasna et al. 2007
<i>Melanchlenus eumetabolus</i>	AY163554	De Hoog et al. 2002
<i>M. oligospermus</i>	AY163555	De Hoog et al. 2002
<i>Metulocladosporiella musae</i>	DQ008138	Crous et al. 2006
<i>M. musicola</i>	DQ008136	Avila et al. 2006
<i>Phaeococcomyces catenatus</i>	AF050277	Untereiner et al. 1999
<i>P. nigricans</i>	AF050278	Untereiner et al. 1999
<i>Phialocephala fluminis</i>	AF486124	Gruenig et al. 2002
<i>Pseudocercospora syzygiicola</i>	AF309600	Crous et al. 2000
<i>Rhinocladiella anceps</i>	EU041805	Arzanlou et al. 2007
<i>Sarcinomyces phaeomuriformis</i>	AJ244259	Hoog et al. 1999
<i>Strelitziana africana</i>	DQ885895	Arzanlou et al. 2006
<i>Strelitziana mali</i> (QX01)	FJ917556	This paper
<i>S. mali</i> (YL06)	FJ917557	This paper
<i>S. mali</i> (YL12)	FJ917558	This paper
<i>S. mali</i> (ZZ21)	FJ917559	This paper
<i>Thysanorea papuana</i>	EU041814	Arzanlou et al. 2007
<i>Veronaea compacta</i>	EU041819	Arzanlou et al. 2007
<i>V. japonica</i>	EU041818	Arzanlou et al. 2007
<i>Zasmidium cellare</i>	EU041821	Arzanlou et al. 2007

related sequence data from GenBank was used to construct a strict consensus tree with tree length = 1689, consistency index (CI) = 0.5281, retention index (RI) = 0.5981, and rescaled consistency index (RC) = 0.3159 (FIG. 1). One major clade had 100% bootstrap support, and another clade included three species

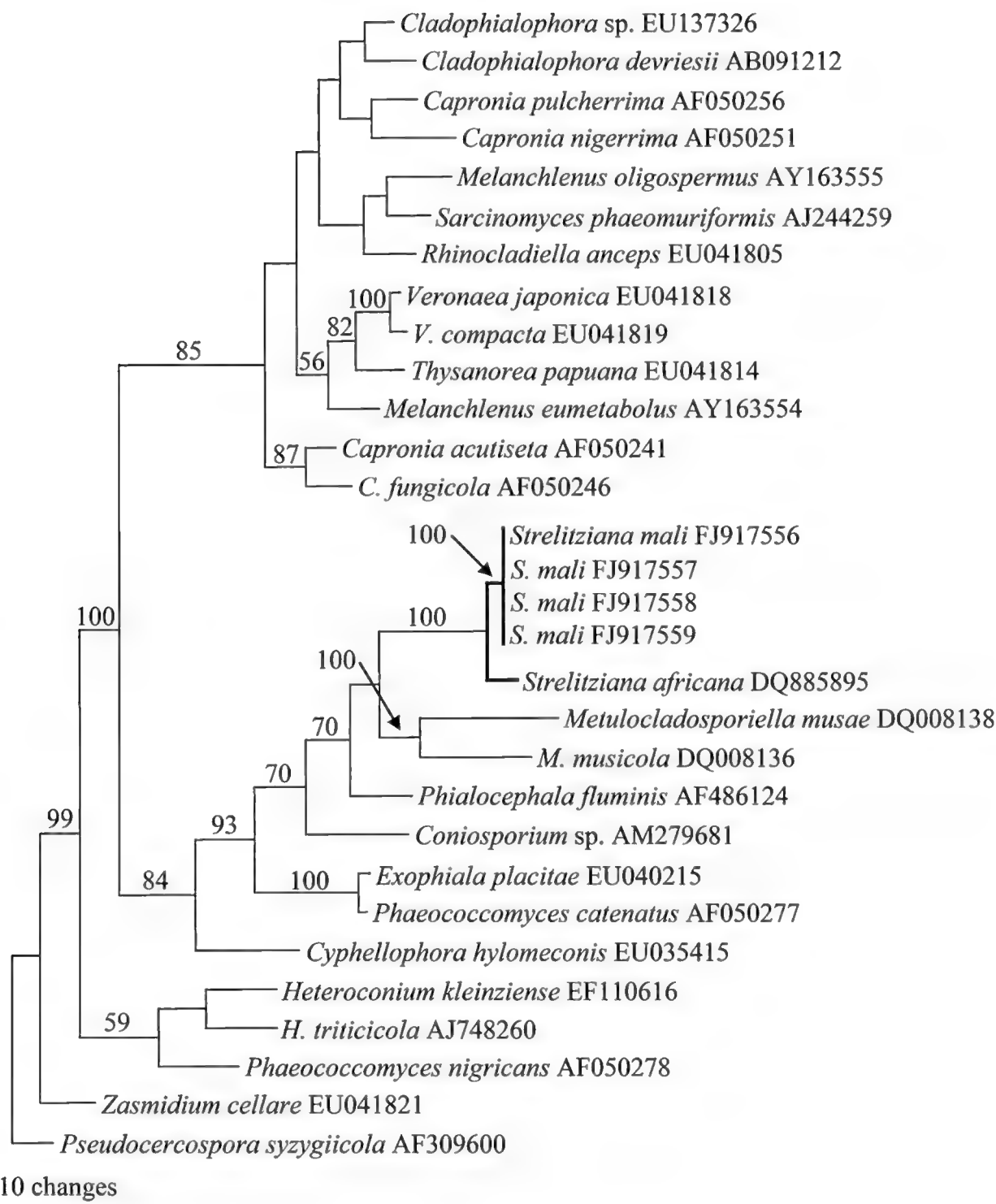


FIG. 1 The majority consensus tree (length = 1689, CI = 0.5281, RI = 0.5981, RC = 0.3159) derived from a heuristic search option in PAUP version 4.0b10 for 32-bit Microsoft Windows with 1000 randomizations of sequence input orders and 1000 bootstrap replications using the data set ITS1, 5.8S and ITS2. Bootstrap values higher than 50% are indicated above the tree branches.

with a lower (59%) bootstrap support. In our tree, our four strains — YL12, YL06, QX01, ZZ21 — clustered together with *Strelitziana africana* with a 100% bootstrap value, indicating that they might represent a new species. Based on

morphological characteristics and molecular phylogenetic analysis, we propose that the four isolates represent a new species of *Strelitziana*.

Taxonomic description

Strelitziana mali Rong Zhang & G.Y. Sun, sp. nov.

FIGS. 2–3

MYCOBANK MB 515170; GENBANK FJ917556

Coloniae in PDA post 30 dies temperature ambiente ad 18 mm diam., purpureo-brunnea, coactae, in medio 3 mm altae; Hyphae hyalinae aut pallide brunneae, septatae, ramosa, aeriae 2–3 µm crassae, submersae saepe ad 3–5 µm inflatae; Conidiophora unicellularia ex hyphis indistinctis vegetativis oriunda, constanter brunnea, cellulae conidiogenae terminal. Conidia hyaline, fusiformia, longa obclavate, (2–)5–10-septata, (12–)35–60(–100) × 7(–35) µm, conidiogenesis microcyclica visa in vitro.

HOLOTYPE: ex cuticulae fructi *Malus × domestica* Borkh., Liquan, Shaanxi, China, HMUABO (Herbarium Mycologicum Universitatis Agriculturae Boreali-Occidentalis) 822502; cultus QX01.

Isolate QX01 was obtained in China from apple (*Malus × domestica*), where it forms mycelial mats with sclerotium-like bodies on the fruit surface. The colony diameter after 1 month on PDA at 25°C reached 24 mm with even margins and smooth, felty aerial hyphae; colony centers are purplish gray and outer zones pale white. Hyphae are hyaline to brown, ramose, septate with aerial hyphae 2–3 µm diam. and submerged hyphae inflated, 3–5 µm diam. Conidiogenous cells terminal, pigmented, thinner than the conidia. Conidia hyaline, thin walled, solitary, fusiform to long obclavate, (12–)35–60(–100) × 7(–35) µm, (2–)5–10-septate. Microcyclic conidiation is present in culture (FIG. 2).

Scanning electron microscope studies showed that conidiogenous cells were erect, solitary, arising from aerial and submerged mycelium, subcylindrical, straight to geniculous-sinuous, terminal, frequently constricted, abscising irregularly or regularly, and produced by a hypha that was thicker than the conidiogenous cell. Conidiogenesis is rhexolytic with remnants of the separating cell clearly visible on both the conidiogenous cell and conidia. Conidia produce secondary spores; hypha and/or conidia are often anastomose (FIG. 3).

Discussion

Previously there was only one species in the genus, *Strelitziana africana*, for which the anamorph–teleomorph connection is unknown. *Strelitziana africana* resembles species of *Pseudocercospora* Speg., which are morphologically variable (Crous et al. 2000). *Pseudocercospora syzygiicola* hyphae give rise to stromata or single conidiophores. The conidiophores are fasciculate and can also arise from a stroma. The conidiogenous cells have unthickened conidial scars, and the conidia have unthickened hilum (Sutton et al. 1997). *Strelitziana africana* lacks the non-thickened conidial scars and stroma.

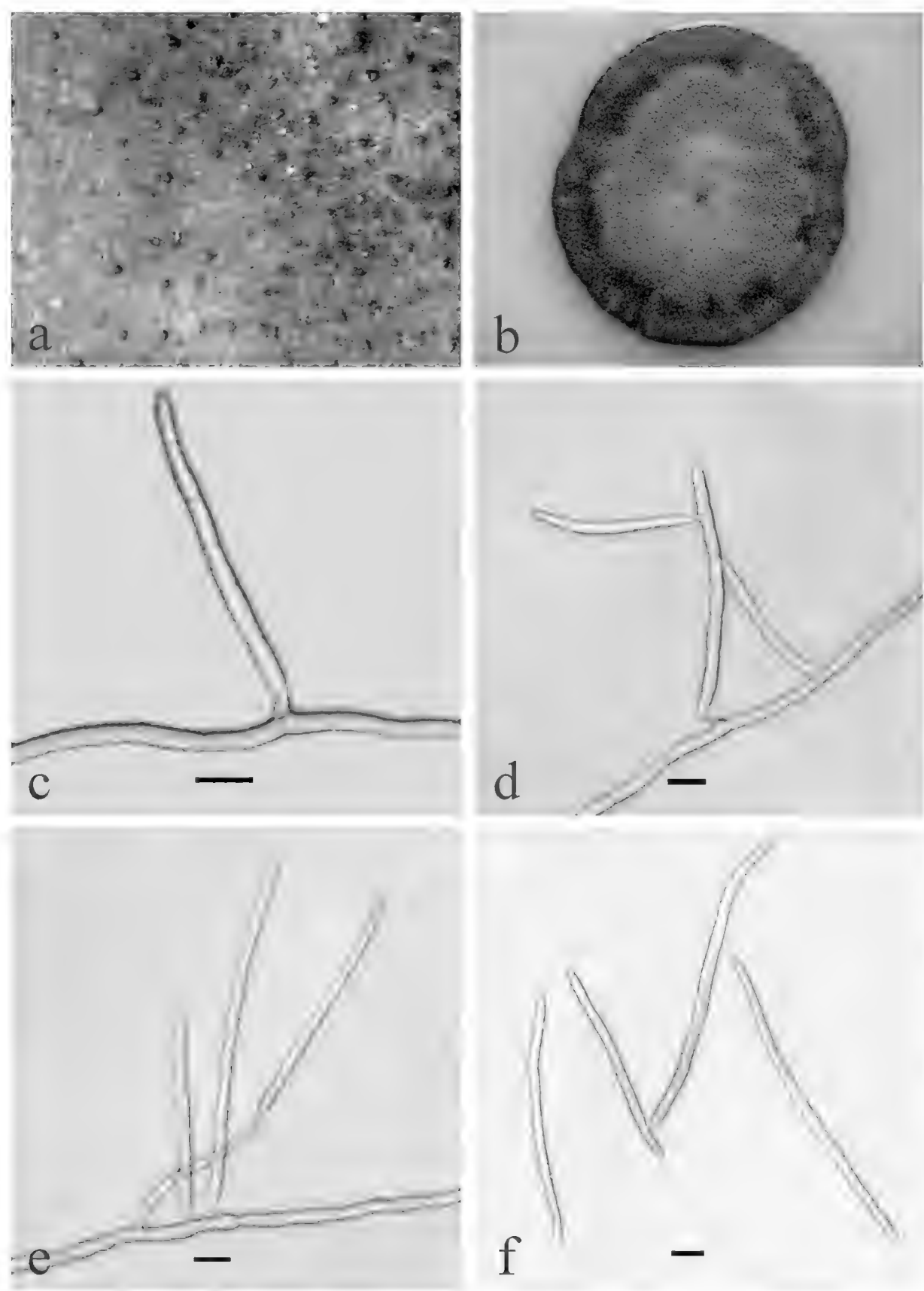


FIG. 2 *Strelitziana mali* QX01

a. Signs on apple peel; b. Colony on PDA; c. Conidia and conidiogenous cell; d. Secondary spores; hypha and conidia often anastomose; e. Single spore fallen off hypha, secondary spores; f. Conidia.
Bars (c–f) =10 μ m.

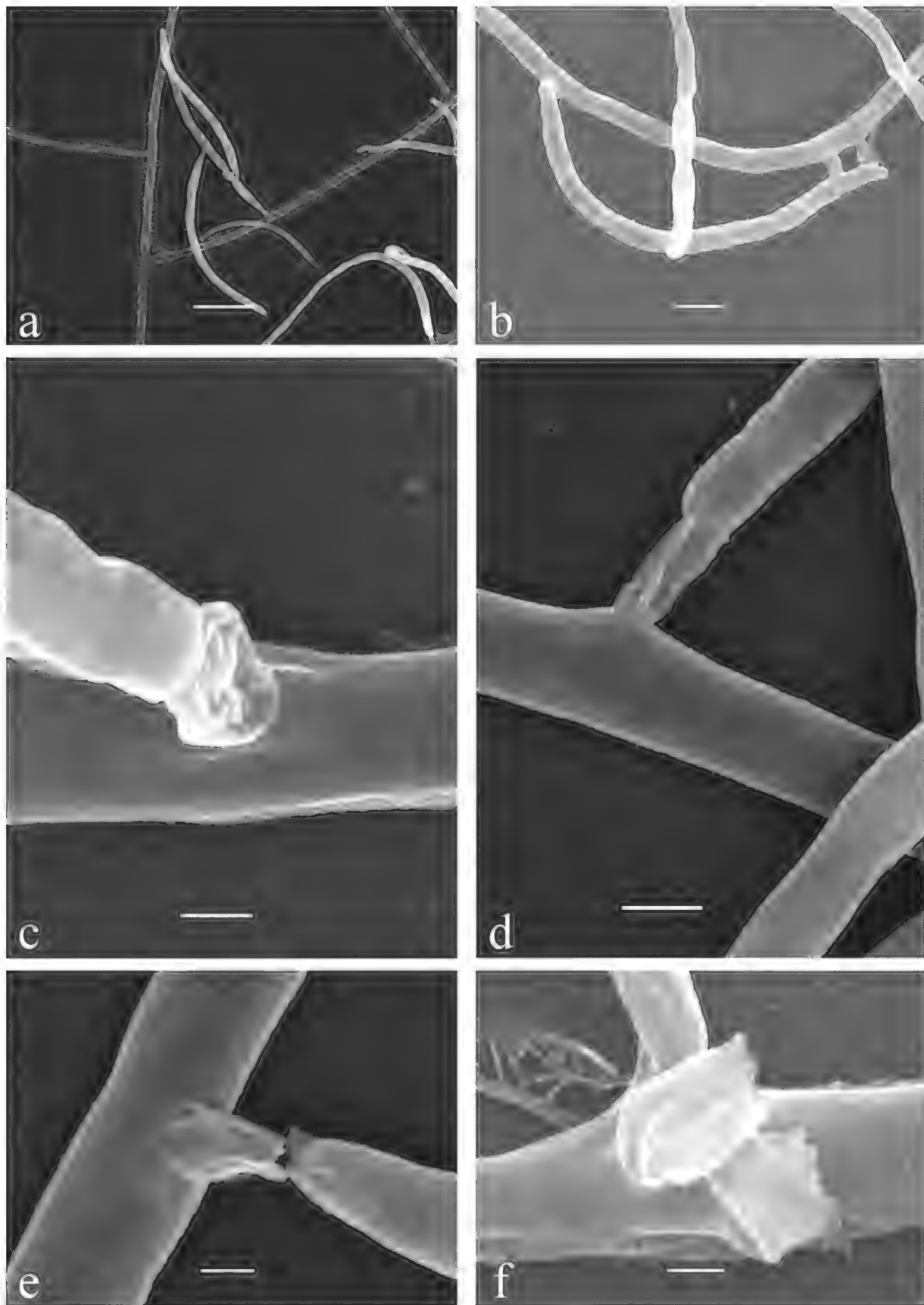


FIG. 3 *Strelitziana mali* QX01 under scanning electron microscopy

a. Secondary spores; b. Anastomosing conidia; c–d. Fasciculation of conidiogenous cell; e. The remnants of separating cell clearly visible on conidia and conidiogenous cell; f. Remnants on conidiogenous cells.

Bars: a = 20 μm ; b = 5 μm ; c–e = 1 μm ; f = 2 μm .

The longer [(12–)35–60(–100) μm] conidia easily distinguish *Strelitziana mali* from *S. africana*. Furthermore, the conidiogenous cell of *S. mali* is very tiny, not easily observed under a light microscope, and produced directly from the hypha in contrast to the *S. africana* conidiogenous cell, which is produced by a conidiophore. The ITS sequence analysis and morphological comparison clearly support describing the isolates from *Malus \times domestica* as a new species of *Strelitziana*.

Acknowledgments

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Literature cited

- Abliz P, Fukushima K, Takizawa K, Nieda N, Miyaji M, Nishimura K. 2003. Rapid identification of the genus *Fonsecaea* by PCR with specific oligonucleotide primers. *Journal of Clinical Microbiology* 41: 873–876.
- Arzanlou M, Crous PW. 2006. *Strelitziana africana*. *Fungal Planet* 1, No. 8. 2 pp.
- Arzanlou M, Groenewald JZ, Gams W, Braun U, Shin HD, Crous PW. 2007. Phylogenetic and morphotaxonomic revision of *Ramichloridium* and allied genera. *Studies in Mycology* 58: 57–93.
- Avila de la Calle A, Groenewald JZ, Trapero A, Crous PW. 2005. Characterization and epitypification of *Pseudocercospora cladosporioides*, the causal organism of *Cercospora* leaf spot of olives. *Mycological Research* 109: 881–888.
- Barnes I, Gaur A, Burgess T, Roux J, Wingfield BD, Wingfield MJ. 2001. Microsatellite markers reflect intra-specific relationships between isolates of the vascular wilt pathogen, *Ceratocystis fimbriata*. *Molecular Plant Pathology* 2: 319–325.
- Crous PW, Aptroot A, Kang JC, Braun U, Wingfield MJ. 2000. The genus *Mycosphaerella* and its anamorphs. *Studies in Mycology* 45: 107–121.
- Crous PW, Hong L, Wingfield BD, Wingfield MJ. 2001. ITS rDNA phylogeny of selected *Mycosphaerella* species and their anamorphs occurring on *Myrtaceae*. *Mycological Research* 105: 425–431.
- Crous PW, Mohammed C, Glen M, Verkley GJM, Groenewald JZ. 2007. Eucalyptus microfungi known from culture. 3. *Eucasphaeria* and *Symptoventuria* genera nova, and new species of *Furcaspora*, *Harknessia*, *Heteroconium* and *Phacidiella*. *Fungal Diversity* 25: 19–36.
- Crous PW, Schubert K, Braun U, de Hoog GS, Hocking AD, Shin HD, Groenewald JZ. 2007. Opportunistic, human-pathogenic species in the *Herpotrichiellaceae* are phenotypically similar to saprobic or phytopathogenic species in the *Venturiaceae*. *Studies in Mycology* 58: 185–217.
- Gruenig CR, Sieber TN, Rogers SO, Holdenrieder O. 2002. Genetic variability among strains of *Phialocephala fortinii* and phylogenetic analysis of the genus *Phialocephala* based on rDNA ITS sequence comparisons. *Canadian Journal Botany* 80: 1239–1249.

- Hoog GS de, Nishikaku AS, Fernandez-Zeppenfeldt G, Padin-Gonzalez C, Burger E, Badali H, Richard-Yegres N, van den Ende GA HG. 2007. Molecular analysis and pathogenicity of the *Cladophialophora carrionii* complex, with the description of a novel species. *Studies in Mycology* 58: 219–234.
- Hoog GS de, Vicente V, Caligiorne RB, Haase G. 2003. Species diversity and polymorphism in the *Exophiala spinifera* clade containing opportunistic black yeast-like fungi. *Journal of Clinical Microbiology* 41: 4767–4778.
- Hall TA. 1999. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucl. Acids. Symp. Ser.* 41:95–98.
- Kwasna H, Bateman GL. 2007. *Heteroconium* sp. nov. from roots of *Triticum aestivum* in the United Kingdom. *Mycologia* 99: 777–785.
- Sert H, Sumbul H, Sterflinger K. 2007. Microcolonial fungi from antique marbles in Perge / Side/ Termessos(Antalya/Turkey). *Antonie van Leeuwenhoek* 91: 217–227.
- Sun GY, Zhang R, Zhang Z, Zhang M. 2003. Isolation of sooty blotch and flyspeck fungi from apple surface by picking up the thalli. *Acta Phytopathologica Sinica* 33: 479–480 [in Chinese].
- Sutton BC, Crous PW. 1997. *Lecanostictopsis* gen. nov., and related leaf-spotting fungi on *Syzygium* species. *Mycological Research* 101: 215–225.
- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins D.G. (1997). The CLUSTAL_X windows interface: Flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* 25:4876–4882.
- Untereiner WA, Naveau FA. 1999. Molecular systematics of the *Herpotrichiellaceae* with an assessment of the phylogenetic positions of *Exophiala dermatitidis* and *Phialophora americana*. *Mycologia* 91: 67–83.
- White TJ, Bruns TD, Lee SB, Taylor JW. 1990. Analysis of phylogenetic relationships by amplification and direct sequencing of ribosomal RNA genes. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds) *PCR protocols: a guide to methods and applications*. Academic, New York, pp. 315–322.
- Zeng JS, Sutton DA, Fothergill AW, Rinaldi MG, Harrak MJ, de Hoog GS. 2007. Spectrum of clinically relevant *Exophiala* species in the United States. *Journal of Clinical Microbiology* 45: 3713–3720.

Report of the Nomenclature Committee for Fungi: 15

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Abstract — The IAPT Permanent Nomenclature Committee for Fungi recommends the following names for conservation: *Pseudocercospora* against *Stigmina* and *Phaeoisariopsis*, *Boletus applanatus* against *B. lipsiensis*, *Lyophyllum* with *L. semitale* as conserved type, *Roccellina* against *Roccellaria*, *Psilocybe* with *P. semilanceata* as conserved type, *Calvatia* nom. cons. against *Lanopila*, and *Phaeographis* (over *Creographa*, *Ectographis*, *Flegographa*, *Hymenodecton*, *Platygramma*, and *Pyrographa*) with *P. dendritica* as conserved type. As a result of reference under Art. 32.4, the Committee recommends that the descriptive statement accompanying publication of Ascomycota Cavalier-Smith be considered adequate for valid publication but recommends that that for Blastocladiomycota Doweld should not.

The previous report of the Nomenclature Committee for *Fungi* appeared in TAXON 57: 637–639 (2008); the current report constitutes Committee recommendations determined from votes received by the Secretary during the April 28–July 3 (2009) voting period. Those voting on Fungal Ballot 2009-1 were J.L. Crane (Urbana-Champaign IL), V. Demoulin (Liege), D.L. Hawksworth (Madrid), T. Iturriaga (Caracas), P.M. Kirk (Egham), P.-G. Liu (Kunming), T. May (Melbourne), L.L. Norvell (Portland OR), S.R. Pennycook (Auckland), C. Printzen (Frankfurt), S.A. Redhead (Ottawa), S. Ryman (Uppsala), and D. Triebel (München). One member did not return a ballot.

A 9-vote minimum is required for the 14-member committee to recommend or reject a proposal for conservation. Committee recommendations are conclusive for seven of eight formal conservation proposals. Two additional recommendations resulted from the Committee's discussion on whether the descriptive statements associated with two phylum names satisfied the minimal requirements of Art. 32(d) for a "description or diagnosis". Outcomes are reported as YES : NO : MORE DISCUSSION+ABSTENTION. Percentages were

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determined from our membership total (14) and not from the number of actual ballots returned (13).

Proposals published in TAXON to conserve or reject

(1732) Conserve the name *Pseudocercospora* against *Stigmina* and *Phaeoisariopsis* (*Hyphomycetes*). Proposed by Braun & Crous. TAXON 55(3): 803. (2006). Votes — 10 : 2 : 1 (71.4% recommend conservation.)

This somewhat controversial proposal was prompted by early molecular data that suggested merging three genera (*Pseudocercospora*, *Stigmina*, *Phaeoisariopsis*) among which one, *Pseudocercospora*, comprises 1000 species. Conservation of *Pseudocercospora* would not rule out using *Stigmina* and *Phaeoisariopsis* for independent genera, while – as one committee member noted – “failure to conserve *Pseudocercospora* as the name for the combined genus would be nomenclaturally disastrous.”

The previous 1 May 2007 ballot delivered 10 votes supporting Prop. 1732 and 5 votes for discussion. In view of the 2009 71% majority and addition of only two new comments since 2007, the Committee now recommends conserving the name *Pseudocercospora* over *Stigmina* and *Phaeoisariopsis* for the combined genus.

(1739) Conserve the name *Boletus applanatus* against *B. lipsiensis* (*Basidiomycota*). Proposed by Redhead, Ginns & Moncalvo in TAXON 55(4): 1029–1030. (2006). Votes – 12 : 0 : 1 (85.7% recommend conservation.)

A well-known ganoderma first published by Batsch (1796) as *Boletus lipsiensis* is also commonly accepted under the epithet ‘*applanatus*,’ introduced by Persoon in 1800. The taxon in question has been subject to much misidentification and nomenclatural confusion. A recent Niemelä & Miettinen type study (2008, TAXON 57: 963–966) concludes that the designated type represents the taxon usually called *G. applanatum*. Although Chair Demoulin’s detailed minority report (in TAXON 59, 2010 in press) was not available for consideration by the Committee prior to return of Ballot 2009-1, the continued strong support for the proposal makes it doubtful that members will ever vote to reject. The proposal is thus forwarded to the General Committee as recommended.

(1742) Conserve the name *Lyophyllum* with a conserved type (*Basidiomycota*). Proposed by Redhead, Hofstetter, Clémenton, Moncalvo & Vilgalys in TAXON 55(4): 1034–1036 (2006). Votes – 10 : 0 : 3 (71.4% recommend conservation).

Recent molecular analyses reveal the original type, *Lyophyllum leucophaeatum*, to be distant from other grey-brown lyophyllums and more closely related to colorful ‘*Calocybe*’-clade taxa. One taxonomic option is to establish most of the

grey-brown pigmented *Lyophyllum* species to a new genus and importing the brightly pigmented species into *Lyophyllum*. The proposers note, “application of the name *Lyophyllum* to a taxonomic group primarily consisting of brightly pigmented species while simultaneously excluding the grey-brown taxa would be a nearly 180° reversal of the current situation where *Calocybe* are colourful and *Lyophyllum* are grey-brown, and would lead to general confusion and great resistance among mycologists.” They offer as a preferred alternative naming and conserving a new type for what has come to be regarded as the ‘typical’ (e.g., grey-brown pigmented) *Lyophyllum* species.

The proposal continues to be viewed favorably by the majority of Committee members, with a 71.4% majority on Ballot 2009-1 now agreeing with the previous 64.7% majority (May 2007 – 11 : 1 : 6) to recommend conserving *Lyophyllum* with *L. semitale* (replacing Karsten’s originally designated *L. leucophaeatum*) as type.

(1756) Conserve the name *Roccellina* against *Roccellaria* (lichenized *Ascomycota*). Proposed by Tehler in TAXON 56(1): 254–255 (2007). Votes – 11 : 0 : 2 (78.6% recommend that *Roccellina* be conserved.).

The proposer contrasts the widespread acceptance of *Roccellina*, published by Darbishire in 1898 and now represented by 27 taxa, to the monotypic and less well-known *Roccellaria*, established a year earlier by the same author. Molecular analyses showing *Roccellaria* nested within a paraphyletic *Roccellina* suggest that if the two taxa are combined into one taxon, the better-known name should have precedence.

(1757) Conserve the name *Psilocybe* (*Basidiomycota*) with a conserved type. Proposed by Redhead, Moncalvo, Vilgalys, Matheny, Guzmán-Dávalos & Guzmán in TAXON 56(1): 255–257. (2007). Votes – 13 : 0 : 0 (92.9% recommend conservation of the genus *Psilocybe* with *P. semilanceata* as type.)

Recent molecular analyses support fragmentation of the large well-known genus, *Psilocybe*, into two major clades. The name *Psilocybe* is almost universally associated with its hallucinogenic representatives, despite the fact that the currently accepted lectotype of the name is the “common moss inhabiting, non-hallucinogenic species, *P. montana*.” *Psilocybe montana* is supported in the major non-hallucinogenic clade that, if generically segregated, would leave “the hallucinogenic species without a generic name.” Additionally, Donk’s 1962 lectotypification by *P. montana* was preceded by a Clements & Shear’s 1931 lectotypification [by *P. merdaria*] and so “cannot be superseded except by conservation.” Prop. 1757 proposes to conserve the name *Psilocybe* with the well-known hallucinogenic *P. semilanceata*, which itself was accepted by many authors as lectotype between 1938-1968). The name *Deconica* (typified

by *Agaricus physaloides* Bull.) is available for the non-hallucinogenic clade.

The proposers offered an alternate proposal (proposal B, not placed on the ballot) that would “leave the typification as generally, but incorrectly, accepted until now”, with *P. montana* as type, after explaining that the previously proposed *P. merdaria* is atypical of the clade and noting that then a new name would be needed for the hallucinogenic clade.

All responding Committee members unanimously voted to conserve *Psilocybe* with *P. semilanceata* as type.

(1770) Conserve *Calvatia* nom. cons. (*Basidiomycota*, *Lycoperdaceae*) against an additional name, *Lanopila*. Proposed by Coetzee & van Wyk in TAXON 56(2): 598–599. (2007). Votes – 13 : 0 : 0 (92.9% recommend conservation.).

Calvatia is a well-known name for a cosmopolitan genus represented by >35 medium- to large-sized puffball species that dehisce through irregular fragmentation of the peridia. Typified by *Lanopila wahlbergii* (now a synonym of *Calvatia argentea*), the earlier named *Lanopila* was incorporated into *Langermannia* 44 years ago, during which time the name fell from common use. Kreisel’s 1992 reincorporation of *Langermannia* into *Calvatia* leaves *Lanopila* as a nomenclatural threat to *Calvatia*.

All Committee members responding unanimously recommend conserving the name *Calvatia* against *Lanopila*.

(1792) Conserve the name *Phaeographis*, with a conserved type, against *Creographa*, *Ectographis*, *Flegographa*, *Hymenodecton*, *Platygramma*, and *Pyrographa* (*Ascomycota*: *Ostropales*: *Graphidaceae*). Proposed by Lücking, Kalb, Staiger & McNeill in TAXON 56(4): 1296–1299. (2007). Votes – 12 : 0 : 1 (85.7% recommends conservation of *Phaeographis*.)

Graphina, *Phaeographina*, and *Phaeographis* were twice proposed for conservation, once in 1930 and again in 1981. Conservation was not recommended due to the ‘uncertain taxonomic application’ of the names. The 1981 proposal was debated for 11 years, rejected due to unsettled taxonomy, reopened for further debate for 6 years and twice more rejected.

The new proposal addresses Staiger’s concept of the *Graphidaceae* that finally sorts out morphologically and molecularly the taxonomic relationships among the genera. The Committee recommends conservation of *Phaeographis* with *P. dendritica* as conserved type.

Special recommendations: clarification on minimal standards for valid publication of higher level taxa

The names *Ascomycota* Caval.-Sm. (in Biol. Rev. 73: 247. 1998) and *Blastocladiomycota* T.Y. James (in MYCOLOGIA 98: 867. 2007 [‘2006’]) as accepted in Hibbett & al. (in Mycol. Res. 111: 509–547) have been adopted in the 10th edition of the DICTIONARY OF FUNGI. Discussion preceding publication of the Hibbett & al. paper, centered on whether the former was validly published and whether the latter had been validly published earlier by Doweld (PROSYLLABUS TRACHEOPHYTORUM: LXXVII. 2001). General Committee Secretary Fred Barrie requested clarification under Art. 32.4 from the Nomenclature Committee for Fungi regarding whether the descriptive statements associate with these names satisfy the requirements of Art. 32.1(d).

Ascomycota Caval.-Sm.: The diagnosis of the phylum *Ascomycota* Caval.-Sm. satisfies the minimum requirements of Art. 32.1(d) for valid publication of the name. Votes – 11 : 1 : 1 (78.6% recommend acceptance of the diagnosis of *Ascomycota* Caval.-Sm. as sufficient for valid publication).

Bold (MORPH. PL.: 7, 180, 1957) first introduced the name *Ascomycota* (at the level of division – now “division or phylum”) but without providing an explicit diagnosis and author citation. Although the name was used by mycologists sporadically thereafter, Cavalier-Smith (in BIOLOGICAL REVIEWS 73: 247. 1998) was the first to distinguish *Ascomycota* from *Basidiomycota* (at the division or phylum level), proposing it as a new name and providing a very short Latin diagnosis: “sporae intracellulares.” A group of concerned mycologists asked the General Committee for a clarification (under 32.4) as to whether the short descriptive statement satisfies the requirements of Art. 32.1(d), and the General Committee referred the question to the Committee for Fungi for its recommendation.

Although Art. 36 [covered by Art. 32.1(e), not Art. 32.1(d)] specifies Latin requirements, the fact that the diagnosis was in Latin should be considered here as well. Under Art. 32.2, the important question regards whether the author published a statement that – in his opinion – distinguished the *Ascomycota* from the *Basidiomycota* (the only two taxa he compared). It appears obvious that Cavalier-Smith was purposely trying to validate many higher-level taxa by fulfilling the requirements of the CODE.

A 78.6% Committee consensus is that the name *Ascomycota* Caval.-Sm. is validly published.

Blastocladiomycota Doweld: The description or diagnosis of the phylum *Blastocladiomycota* Doweld satisfies the minimum requirements of Art. 32(d) for valid

publication of the name. Votes – 2 : 9 : 2 (~64% do not consider that the description meets minimal standards for valid publication of the name).

In the appendix, Doweld proposed to validate the name “*Blastocladiomycota*” as the name of a phylum, by referring to the Latin diagnosis (“zoospora cilio unico instructa”) under the presumably descriptive (Art. 16.1(b)) “infraphylum” name *Allomycotina* Caval.-Sm. (l.c.: 246) that cannot be treated as a validly published automatically typified name derived from *Allomyces* as the family name (*Allomycetaceae*) had never been proposed. Doweld (in accordance with, but not citing, Art. 16.1) replaced all higher-level names not based upon legitimate family names with names based upon those with legitimate family names. Although not strictly part of the reference, the Committee took the view that *Blastocladiomycota* cannot be interpreted as a nomen novum based on *Allomycotina* but must be interpreted as a wholly new name that requires a Latin description or diagnosis to be validly published.

Hence, the Committee considered that it was the adequacy of the Latin diagnosis that was in question: Cavalier-Smith’s brief Latin diagnosis for *Allomycotina* (translated as “with uniciliate zoospores;” 1998, p. 266) makes sense within the framework of his own classification (*Allomycotina* < subphylum *Melanomycotina* < phylum *Archemycota* < subkingdom *Eomycota*) where subphyla within *Archemycota* were differentiated by features of the Golgi apparatus. His framework permitted differentiation of “infraphyla” *Allomycotina* and *Zygomycotina* based on presence of uniciliate zoospores because the other uniciliate taxa in *Archemycota* were in a different subphylum (*Dictyomycotina*), where the class *Chytridiomycetes* was placed.

On the other hand, Doweld’s application of a Latin diagnosis appropriate within one classification framework to a taxon in a different classification scheme fails because the diagnosis does not serve to differentiate *Blastocladiomycota* from *Chytridiomycota* while placing the two phyla together in one subkingdom (*Mucoromycotina*) where many taxa in both phyla produce uniciliate zoospores. *Blastocladiomycota* and *Chytridiomycota* are thus not differentiated from each other. Taken out of context, the cited Latin fails to be a “statement of that which in the opinion of its author [Doweld] distinguishes the taxon from other taxa” (Art. 32.2). Because Doweld fails to distinguish the phyla in subkingdom *Mucoromycotina* from each other, “zoospora cilio unico instructa” does not fulfill Art. 32.1d and the Latin phrase cannot be considered a diagnosis.

A 64.3% majority of the Committee feels that because the descriptive statement is not in this context diagnostic, it does not satisfy the requirement of Art. 32(d) for a description or diagnosis by which the phylum name “*Blastocladiomycota* Doweld” is validly published.

Fungal nomenclature. Proposals to conserve or reject

Abstract — Formal proposals to conserve or protect fungal names are published concurrently in MYCOTAXON and TAXON. Authors of Prop. 1861 (to conserve the name *Aspicilia farinosa* with a conserved type) amend their proposal to reflect an earlier combination date. Complete proposals include Prop. 1896 (to conserve the name *Lichen lichenoides* against *L. tremelloides* and *L. tremella*), Prop. 1897 (to reject the name *Lecidea epiploica*), Prop. 1898 (to conserve *Stirtonia* A.L. Sm. against *Stirtonia* R. Br. bis), and Prop. 1899 (to conserve the name *Hebeloma cylindrosporum* against *H. angustispermum*).

Proposal 1861 to conserve *Aspicilia farinosa*: author correction*

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After the publication of our proposal (Nordin & Roux 2009. Proposal to conserve the name the name *Aspicilia farinosa* (Ascomycota: Pertusariales: Megasporaceae) with a conserved type. TAXON 58: 292), Bernard Abbott correctly pointed out to us that *Aspicilia farinosa* had been combined into *Aspicilia* at an earlier date than generally assumed (by us, Zahlbruckner, and Hue as well as in INDEX FUNGORUM), namely in Flagey 1888: 131 (Flagey, C. 1888: Herborisation lichénologique dans les environs de Constantine (Algérie). REVUE MYCOLOGIQUE 10: 126-134.) This does not affect the conservation proposal other than that the author citation ought to be changed to *Aspicilia farinosa* (Flörke) Flagey instead of *Aspicilia farinosa* (Flörke) Hue.

*This correction will not appear in TAXON but form a part of the on-going deliberations by the Nomenclature Committee for Fungi.

**Proposal 1896: to conserve the name
Lichen lichenoides (*Leptogium lichenoides*) against *Lichen
tremelloides* and *L. tremella* (lichenized *Ascomycota*)**

[As published in TAXON* 58: 1002–1003]

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(1896) *Lichen lichenoides* Wulfen in Jacquin, COLLECTANEA 3: 136. 1791 (sero),
nom. cons. prop. TYPUS: Sweden, Herb. Linnaeus No. 1276.9 (lower specimen) (LINN),
typ. cons. prop.

(=) *Lichen tremelloides* Weiss, Pl. Crypt. Fl. Gott.: 52. 1770, nom. rej. prop.
LECTOTYPUS (**hic designatus**): [icon in] Dillenius, HIST. MUSC.: t. 19, f. 31.
1742. EPITYPUS (**hic designatus**): Herb. Dillenius No. 19.31A, (OXF).

(=) *Lichen tremella* Roth, Tent. Fl. Germ. 1: 503. Feb– Apr 1788, nom. rej.
prop. NEOTYPUS (**hic designatus**): Sweden, Herb. Linnaeus No. 1276.9 (lower
specimen) (LINN).

In a recent paper dealing with the typification of Linnaean algal names (Spencer & al. in TAXON 58: 237–260. 2009) it was noted that “*Tremella* L.” as typified by Donk (in TAXON 7: 236–250. 1958) applies to a genus of heterocystous *Nostocaceae* with a starting-point date of 1892 under Art. 13.1 (e) of the ICBN (McNeill & al. in REGNUM VEG. 146. 2006). Thus “*Tremella lichenoides* L.”, long considered as the basionym of a widespread and well-known *Leptogium* species, is not validly published.¹ Spencer & al. suggested that the correct name for this species should be *Leptogium lichenoides* (Wulfen) Zahlbr. This is, however, a more complicated case in need of further study and action.

According to Zahlbruckner (CAT. LICH. UNIV. 3: 136. 1924) there are two older names applicable to this species, neither of which have been considered legitimate previously:

(1) *Lichen tremelloides* Weiss (l.c.) which hitherto has been regarded as illegitimate since Weiss cited the older “*Tremella lichenoides* L.”, but

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¹ Nomenclature Editor’s footnote: It can, however, be argued that as *T. nostoc* must be typified by a blue-green algal element, it was not validly published in 1753 and so is not a “simultaneously published species name” (Art. 10.2), being pre-starting date for *Nostocaceae Heterocystaeae*, and so is ineligible for selection as type of *Tremella*. This would appear contrary to the intent of Art. 13.2, which originated in the SEATTLE CODE (Stafleu & al. in REGNUM VEG. 82. 1972).

because our understanding of its status has changed, Weiss's name now is the eldest legitimate one for the species. Since Weiss's herbarium appears to have been lost, it is necessary to designate one of the cited illustrations as lectotype, the best choice being that of Dillenius of which the original specimen is known, one which I have once studied (Jørgensen & James in *LICHENOLOGIST* 15: 113. 1983) and which is a suitable epitype.

(2) *Lichen Tremella* Roth (l.c.). Roth also cites *Tremella lichenoides* L. and he apparently wanted to transfer this to *Lichen*, but most possibly disliked the tautonymoid name that would result. He therefore coined a completely new name, using the Linnaean generic name as the epithet instead. Since Roth's main herbarium was lost during the Second World War and no other specimens have been traced, and as no illustrations are cited, it is necessary to designate a neotype. Because Roth appears to have wanted to transfer the Linnaean species into what he considered the correct genus, I find it best to designate the excellent Linnaean specimen (see further Jørgensen & al. in *BOT. J. LINN. SOC.* 115: 261–405. 1994) as neotype.

According to this the correct name for the species would be *Leptogium tremelloides* (Weiss) Fr., unless that name or its basionym is rejected in favour of Wulfen's name.

It is, however, necessary to check on Wulfen's text in Jacquin (l.c.), the third volume of which according to Stafleu & Cowan (in *REGNUM VEG.* 98: 412. 1979) was published late in 1791, rather than in 1789 as the title page indicates. Wulfen reports finding material of this lichen near Klagenfurt and other localities in Carinthia, and illustrates his own material, the presence of which is unknown at the moment as only a few of his cryptogamic collections appear to have survived. His illustration most probably shows the alpine form which Otalora & al. (in *TAXON* 57: 907–921. 2008) on the basis of molecular work claimed to be a species of its own and incorrectly named *Leptogium pulvinatum* (Hoffm.) Otalora. The type of this name is from a garden path in Cambridge, England and represents an extreme expression of *Leptogium lichenoides*, which converges towards the alpine form, such lowland forms not being included or discussed in their study.

In his discussion Wulfen makes it clear that his intention is to transfer the Linnaean epithet from the genus *Tremella*, which he obviously regarded as a non-lichenized cyanobacterial genus, to the genus *Lichen*, on the basis of the newly discovered fruiting-bodies, as well as differences in the thallus structure. In doing so he validated the Linnaean epithet, but unfortunately in an illegitimate name, as he cited *Lichen tremelloides* Weiss as a synonym. In consequence, under Art 7.5, the type of *L. lichenoides* is the type of *L. tremelloides*. Since,

however, conservation is necessary anyway, I find it best to conserve Wulfen's name with the fine Linnaean specimen as the type, for the same reason as given for *Lichen tremella*, thus preserving the intentions of Wulfen (and Roth).

It would be most unfortunate to have to change the name *Leptogium lichenoides*, the type of the generic name *Leptogium* (Greuter & al. in REGNUM VEG. 129: 623. 1993). This name is widely and persistently used in checklists and floras in the temperate regions of both hemispheres too numerous to list here, but including Verdoon (in FL. AUSTRAL. 54: 586. 1992) and Santesson & al. (Lichen-form. LICHENICOL. FUNGI FENNOSCAND.: 187. 2004). I accordingly propose Wulfen's name for conservation.

If the proposal is accepted, the species retains its familiar name, though with a slight change in author-citation as suggested by Spencer & al. (l.c.)

If on the other hand this proposal is not accepted, further nomenclatural actions are needed since the combination "*Leptogium tremelloides* (Weiss)" does not appear to exist, and is blocked by the homonymic *Leptogium tremelloides* S.F. Gray. This name was based on the illegitimate *Lichen tremelloides* L. fil., which is the lichen now correctly called *Leptogium cochleatum* (Dicks.) P.M. Jørg. & P. James (see further Jørgensen & James, l.c.). It would therefore be necessary to reactivate the rather unfortunate, long forgotten, *Lichen tremella* Roth, which neither has been transferred to *Leptogium*, and is better rejected to the benefit of *Leptogium lacerum* (Retz.) S.F. Gray. The proposal advanced here, is a much better alternative.

Acknowledgements

I am above all thankful to John McNeill, Edinburgh for helping me to get on the right track when trying to resolve the rather unexpected threat to the stability of this name, and for his willingness to comment on several versions of the manuscript. I am further indebted to Per Sunding, Oslo and Christian Printzen, Frankfurt who kindly assisted in locating old literature.

Proposal 1897: to reject the name *Lecidea epiploica* (lichenized Ascomycota)

[As published in TAXON* 58: 1003–1004]

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(1897) *Lecidea epiploica* Norman in BOT. NOT. 1867: 87. 1867, **nom. rej. prop.**
HOLOTYPUS: Norway, Troms, Sørreisa, Middagsfjellet, J.M. Norman (O)

In our study of poorly known lichen names in Scandinavia (Jørgensen & Nordin in GRAPHIS SCRIPTA 21: 1–20. 2009), we came across one name, *Lecidea epiploica* Norman which had not been in use since Th. Fries (LICHENOGR. SCAND.: 504–505. 1874), though Olivier (BULL. GÉOGR. BOT. 25: 93–183. 1915) included it in his European key to the lichen genus *Lecidea*, based on Fries's treatment. The type proved to be an unusual specimen of the lichen presently known as *Calvitimela perlata* (Haugan & Timdal) R. Sant. (Santesson & al., LICHEN-FORM. LICHENICOL. FUNGI FENNOSCAND.: 73. 2004), a younger name which has recently been clarified. We saw no reason to destabilize the situation by making a new combination before the case had been put before the nomenclature committee. This we now do.

When Th. Fries (l.c.: 534) published *Lecidea bullata* (Körber) Th. Fr. (= *Lecidella bullata* Körber) as a new lichen species to Scandinavia, he made an illegitimate combination, overlooking the older (from 1843) *Lecidea bullata* Meyen & Flotow which is an entirely different lichen, now regarded as a *Toninia* A. Massal. (Timdal in OPERA BOT. 110: 48. 1992). Zahlbruckner (CAT. LICH. UNIV. 3: 530. 1925) corrected this and introduced the new name *Lecidea bullosa* A. Zahlbr.

However, when Magnusson (in MEDDEL. GÖTEB. BOT. TRÄDG. 6: 94. 1931) revised the *Lecidea elata* group, he discovered that Fries had misinterpreted Körber's original description and that Fries's material from Dovre (Norway) actually was a different species in need of a new name for taxonomic reasons, and he renamed the material, *Lecidea perlata* H. Magn. Magnusson thus created another illegitimate name, overlooking the older *Lecidea perlata* Hue

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(from 1915), an Antarctic species now regarded as belonging in *Buellia* De Not. (Lamb in SCI. REP. BRIT. ANTARC. SURV. 61: 41. 1968). When Haugan and Timdal (in GRAPHIS SCRIPTA 6: 17–26. 1994) revised some Arctic-alpine species in the genus *Tephromela* M. Choisy, they reclassified this species and took up Magnusson's epithet in that genus as *Tephromela perlata* Haugan & Timdal, a legitimate name. It became clear in recent years that it was better placed in the segregated genus *Calvitimela* Hafellner from 2001, so it was transferred there by Santesson & al. (l.c.) in their standard work of Scandinavian lichen nomenclature. Since it has a rather restricted distribution, the name has not been much cited since 1994, but it was used by Andreev (in NOVOSTI SIST. NIZSH. RAST. 37: 189. 2004) so it is also in use in the other region from which it is known.

We do not think it should be necessary to introduce a new epithet now, particularly since the type specimen of *Lecidea epiploica* is not typical in that it grew at the base of a tree (instead of being saxicolous) and lacks the characteristic fatty acids of the species (Jørgensen & Nordin, l.c.). Accordingly we propose that this already forgotten name be rejected in order to maintain nomenclatural stability.

**Proposal 1898: to conserve
Stirtonia A.L. Sm. (lichenized Ascomycota, Arthoniales) against
Stirtonia R. Br. bis (Bryophyta, Dicranales)**

[As published in TAXON* 58: 1004]

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(1898) *Stirtonia* A.L. Sm. in TRANS. BRIT. MYCOL. SOC. 11: 195. 1926, **nom. cons. prop.**
TYPUS: *Stirtonia obvallata* (Stirt.) A.L. Sm. (*Cryptothecia obvallata* Stirt.)

(=) *Stirtonia* R. Br. bis, in TRANS. & PROC. NEW ZEALAND INST. 32: 149. 1900
[*Musci*], **nom. rej. prop.** TYPUS: *S. mackayi* R. Br. bis

The monotypic moss genus *Stirtonia* R. Br. bis, including *S. mackayi* R. Br. bis as the only species, was made public during a reading before the Philosophical Institute of Canterbury [New Zealand] on 4 October 1899 and formally described the following year (Brown, l.c.). That author noted the close affinity of *Stirtonia* with *Trematodon* Michx. (*Dicranales*), and *S. mackayi*, the type, was transferred to *Trematodon* by V.F. Brotherus (in Engler & Prantl, NAT. PFLANZENFAM. 1(3): 292. 1901). *Stirtonia* R. Br. bis thus became a synonym of *Trematodon*. The name *Trematodon mackayi* (R. Br. bis) Broth. has been in continuous use since then (e.g., Roth in AUSSEREUROPE. LAUBMOOSE 1(3), Dresden: 193–272. 1911; Dixon in BULL. NEW ZEALAND INST. 3: 31–74. 1914; Fife in BRYOLOGIST 98: 313–337. 1995), while *Stirtonia mackayi* was only mentioned in the original publication.

Stirtonia A.L. Sm. was described for a small group of tropical lichens related to, and previously placed in, *Cryptothecia* Stirt. (Smith in TRANS. BRIT. MYCOL. SOC. 11: 195. 1926). The two genera were referred to a separate family, *Cryptotheciaceae* A.L. Sm., based on the ascomata structure, the ascus type and the byssoid vegetative thallus. *Cryptotheciaceae* is now included in *Arthoniaceae* Rchb. (Lumbsch & Huhndorf in MYCONET 13: 1–58. 2007), but this placement has been doubted (Thor in SYMB. BOT. UPSAL. 32(1): 267–289. 1997). Two species were included in *Stirtonia* in the original publication, namely *S. obvallata* (Stirt.) A.L. Sm. (originally published as *S. obvallata* “A.L. Sm.” but authorship corrected via Art. 33.2) and *S. dubia* A.L. Sm. (Smith in TRANS. BRIT. MYCOL.

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Soc. 11: 189–196. 1926). *Stirtonia obvallata* was selected as the lectotype of the generic name in a recent monographic treatment of *Stirtonia* (Makhija & Patwardhan in MYCOTAXON 67: 293. 1998). Nineteen *Stirtonia* species had by then been published (Awasthi & Singh in GEOPHYTOLOGY 1: 97–102. 1972; Makhija & Patwardhan in BIOVIGYANAM 13(2): 43–51. 1987; Cengia Sambo in ANN. BOT. 22: 19–41. 1940; Santesson in SYMB. BOT. UPSAL. 12(1): 1–590. 1952; Trivelli Ricci in ATTI IST. BOT. LAB. CRITTOG. UNIV. PAVIA, ser. 5, 19: 39–45. 1962), twelve of which were accepted as good species (Makhija & Patwardhan in MYCOTAXON 76: 287–311. 1998). *Stirtonia sprucei* R. Sant. has been transferred to *Amazonomyces* Bat. & Cavalc. (Lücking & al. in LICHENOLOGIST 30(2): 134. 1998) and *S. macrocephala* R. Sant. to *Eremothecella* Syd. & P. Syd. (Thor & al. in SYMB. BOT. UPSAL. 32(3): 39. 2000). The generic placement of the other excluded species is unclear at present. Two additional species have been published, namely *S. biseptata* Aptroot & Wolseley and *S. psoromica* Aptroot & Wolseley (Wolseley & Aptroot in BIBLIOTH. LICHENOL. 99: 411–422. 2009). The secondary chemistry of *Stirtonia ramosa* Makhija & Patw. was investigated by Culberson & al. (in BRYOLOGIST 93: 279–282. 1990). Obviously, there is no further published information on *Stirtonia* as recently defined.

Although *Stirtonia* A.L. Sm. is a small genus whose 14 species are apparently rare and only seldom collected, the name is well established among lichenologists working in tropical countries and has been in continuous scientific use to the present day. Given the fact that *Stirtonia* R. Br. bis has not been used except in the original description and is now included in *Trematodon*, it seems appropriate to conserve *Stirtonia* A.L. Sm. against it in order to ensure taxonomic stability. There is no older name available for *Stirtonia* A.L. Sm., and the introduction of a new generic name including up to 14 new combinations is unavoidable should the present proposal be rejected. The one possible detrimental result would be if *S. mackayi* were to be demonstrably phylogenetically distinct at the generic level from the type of *Trematodon*.

Stirtonia Van Wyk & Schutte (in NORD. J. BOT. 14(3): 320. 1994) (*Fabaceae*) is an illegitimate, third homonym, already replaced by *Stirtonanthus* Van Wyk & Schutte.

**Proposal 1899: to conserve the name
Hebeloma cylindrosporum against
Hebeloma angustispermum (Basidiomycota)**

[As published in TAXON* 58: 1005]

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(1899) *Hebeloma cylindrosporum* Romagn. in BULL. Soc. Mycol. France 81: 330. 1965,
nom. cons. prop. TYPUS: France, Forêt d'Ermenonville (Oise), in pinetis arenosis, 27
Oct 1961, ex herb. Romagnesi (no. 61.262) (PC).

(=) *Hebeloma angustispermum* A. Pearson in TRANS. BRIT. MYCOL. SOC. 33:
301. 1951 ("1950"), **nom. rej. prop.** TYPUS: South Africa, Cape Province,
Bergvliet Retreat, under *Pinus pinea*, 26 Mai 1948. A.A. Pearson 46 (K).

Hebeloma cylindrosporum is a common agaric in pine forests all over Europe,
easily distinguished from other *Hebeloma* species by the narrow, almost
cylindrical spores, hence the epithet. For decades the name has been used
consistently in European treatments of the genus (Bruchet in BULL. MENS.
SOC. LINN. SOC. BOT. LYON 39, Suppl. 6: 86. 1970; Vesterholt in FUNGI N.
EUROPE 3: 114–115. 2005), as well as in European fungal floras (Moser in KL.
KRYPTOGAMENFL. II/2. 1983; Horak, RÖHRLINGE & BLÄTTERPILZE EUROPA:
377. 2005; Vesterholt in Knudsen & Vesterholt, FUNGA NORDICA: 814. 2008).
Since being described in 1951, very little attention has been drawn to the name
Hebeloma angustispermum. Based on type studies, Grilli (in MICOL. VEG. MEDIT.

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Scott A. Redhead.

21: 3–34, 2006) was first to call attention to the synonymy of *H. cylindrosporum* with *H. angustispermum*. Sequence data derived from the holotypes (see collection data above) of *H. cylindrosporum* (ITS sequence GenBank accession no. FJ769356) and *H. angustispermum* (ITS sequence GenBank accession no. FJ769357) confirm Grilli's results.

Hebeloma cylindrosporum is a widely used name, in particular by many researchers working on mycorrhizae. The importance of the name *Hebeloma cylindrosporum* in academic research can be demonstrated by the number of citations in scientific literature using this name. A bibliographic search through the two international databases of scientific literature: ISI Web of Science (<http://www.isiknowledge.com/>) and Scopus (<http://www.scopus.com/>) has recorded the name *Hebeloma cylindrosporum* in the title of 67 scientific publications and in at least 585 different published works originating from 30 different countries. By comparison, a similar search using the name *Hebeloma angustispermum* as input failed to find any record. The species referred to as *Hebeloma cylindrosporum* is one of the six most intensively studied species of ectomycorrhizal fungi. It is used as a model because its mycelium is easy to grow *in vitro* and its entire life cycle can be completed under controlled conditions (Debaud & al. in NEW PHYTOL. 105: 429–435, 1987; Marmeisse & al. in NEW PHYTOL. 163: 481–498, 2004). This latter feature has so far not been achieved for any other ectomycorrhizal fungus. These properties of this species have allowed scientists to explore different fields of mycorrhizal research such as physiology, molecular functioning, ecology, and population genetics and to make significant advances in understanding the biology of mycorrhizal symbiosis. This research has also led to the development of important collections of fungal strains as well as of DNA sequences deposited in the EMBL/DDJB/GenBank database.

For the reasons mentioned above, we find that a name change for this well-known species would be unfortunate. Therefore, with reference to Art. 14.1–2, we propose *H. cylindrosporum* to be conserved against *H. angustispermum*. We further note that confusion with an earlier name, *Agaricus spoliatus* Fr. (EPICR. SYST. MYCOL.: 182, 1838 [‘1836–1838’]), is not relevant. Gröger (in Z. MYKOL. 53: 50, 1987) argued for the synonymization of *Hebeloma spoliatum* (Fr.) Gillet (1876) with *H. cylindrosporum* but adoption of the name *H. spoliatum* has not been generally accepted. The basionym, *Agaricus spoliatus* Fr. (l.c.) has not to our knowledge been typified. Grilli (l.c.: 14) discussed the identity of *H. spoliatum* and pointed out that *Agaricus spoliatus* Fr. was described from mountainous coniferous forests, whereas *H. cylindrosporum* is a lowland species from sandy pine forests. Primarily for this reason, we do not believe *A. spoliatus* applies to the same species as *H. cylindrosporum*, and the identity of *A. spoliatus* and its typification will be dealt with separately.

Proposals to amend the Code

(**001–002) Proposals to add two examples on the valid publication of the names of higher-level taxa

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Arising from a reference under Art. 32.4 to the Nomenclature Committee for Fungi as to whether the descriptive statements associated with *Ascomycota* and *Blastocladiomycota* by Cavalier-Smith and Doweld, respectively, satisfied the requirement of Art. 32.1(d) for a “description or diagnosis”, it appeared that it would be useful to include in the CODE specific examples of the application of Art. 32.4 in light of the recommendations of the Committee (Norvell in TAXON 59: in press. 2010). Accordingly I propose the following two new examples:

(001) Insert the following new example following Art. 32.4:

Ex. 6bis. *Ascomycota* Caval.-Sm. (as ‘*Ascomycota* Berkeley 1857 stat nov,’ BIOL. REV. 73: 247. 1998) was validly published as a phylum name, minimally fulfilling requirements for Art. 32.1(d) via the diagnosis “*sporae intracellulares*” that, in the opinion of the author (Art. 32.2), served to differentiate it from the only other phylum in the subkingdom in his classification. Berkeley (INTRO. CRYPT. BOT.: 270. 1857) had introduced the name *Ascomycetes* [not *Ascomycota*] as a replacement for ‘*Endotheques*, Lev.’ and applied it to an ambiguously ranked taxon.

(002) Insert the following new example following that in Prop. 001:

Ex. 6ter. Doweld (PROSYLLABUS TRACHEOPHYTORUM: LXXVII. 2001) proposed ‘*Blastocladiomycota* nom. nov.’ purposely to be an automatically typified name (Art. 16.1(a)) at the rank of phylum to replace the presumably descriptive (Art. 16.1(b)) ‘infraphylum’ name *Allomycotina* Caval.-Sm. (BIOL. REV. 73: 246. 1998), which lacked an included family with a validly published

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**The proposals have not yet been assigned their official numbers by TAXON. The formal numbers will be accordingly updated in this section in MYCOTAXON 111 (2010).

name based upon the presumed same generic stem name, *Allomyces* E.J. Butler. In the absence of an original Latin description or diagnosis, Doweld specifically cited the Latin description published by Cavalier-Smith for *Allomycotina* (l.c.), “*zoospora cilio unico instructa*” that minimally served to differentiate two “infraphyla” in Cavalier-Smith’s classification. Through an oversight, the Latin phrase contradicts Doweld’s own classification wherein other phyla within the kingdom as circumscribed by Doweld included taxa with uniflagellate zoospores. Therefore, citation of the previously published contradictory Latin phrase (Doweld l.c. 2001) failed to fulfil the requirements of Art. 32.2. The phylum name was later validly published as *Blastocladiomycota* T.Y. James (in MYCOLOGIA 98: 867. 2007 [‘2006’]).

Can we really afford an International Code of Mycological Nomenclature?

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Abstract — Proposals for establishing a new INTERNATIONAL CODE OF MYCOLOGICAL NOMENCLATURE are deemed unwise and unrealistic.

Key words — INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE, history

It is clear that there is now a strong undercurrent determined to pursue adoption of a new CODE OF MYCOLOGICAL NOMENCLATURE for fungal names. The recent proposals by Hawksworth & al. (2009) take the other route, modifying the current INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE (ICBN), including renaming that as the INTERNATIONAL CODE OF BOTANICAL AND MYCOLOGICAL NOMENCLATURE.

This journal has from its inception in 1974 carried as its masthead the information that is devoted to fungal taxonomy and nomenclature. The founding co-editors, Grégoire Hennebert and I, were first and foremost taxonomists, but deeply involved with the code (rules and regulations) of nomenclature, to the point of considering ourselves as nomenclaturalists. By no means are all taxonomists interested in involving themselves in changing and interpreting the Codes governing their names, and many only reluctantly attempt to follow the dictates of such Codes. The cladists, aware that the Hennigian process leads to the impossibility to name or even rank taxa, are prepared to discard our Codes and take up a new PhyloCode.

Continuing efforts to bring together a unified Code covering all organisms have never gained much ground. Bacteriologists and virologists, unsatisfied with either the Botanical Codes or the Zoological Codes have established their own Codes. Even within the botanical community there is a separate International Code of Nomenclature for Cultivated Plants.

The reason that fungi have been, since the very earliest Codes, treated as “plants” is that most have been studied by botanists, not zoologists. Our current understanding that the fungi are far more closely related to animals than plants is

not a valid argument to remove them from a Botanical Code for nomenclatural decisions. In the same issue of MYCOTAXON in which the paper by Hawksworth & al. (2009) appeared is another by Redhead & al. (2009), proposing that the ICBN be amended by excluding the phylum *Microsporidia*, a group of probable fungal relatives that has always been treated as animals and which can be accommodated under the current Zoological Code. This pragmatic solution solves the problem that if these were to be considered under the ICBN, most of the names proposed would not be valid under that code (e.g., most lack a required Latin diagnosis/description when published after 1935).

Would a Mycological Code solve problems? I raise these issues here aware that my joining this debate has only my personal involvement with the ICBN as an excuse. My Ph.D. thesis work (Korf 1952) had alerted me to many nomenclatural problems. I became a Life Member of the International Association of Plant Taxonomists, publishers of the journal TAXON, the official journal of the International Botanical Congresses, and served for decades as a member and Secretary of their Committee on Fungi (and Lichens), and later as a member of their General Committee. Over 100 of my publications have been wholly or mainly nomenclatural. I have also taught courses in Botanical Nomenclature in both the Plant Pathology Department and in the Bailey Hortorium unit at Cornell University over several decades. From my perspective I find little excuse for withdrawing from the ICBN to establish a separate Mycological Code. My major reasons are these:

- The Botanical Code has been amended in many ways to accommodate the special problems of fungi, with the problems of multiple life stages being separately named (Art. 59) surely the most contentious (and most consistently revised) article in the Code, with the concept and application of sanctioned fungal names a probable close second. Would a separate Mycological Code do better at these issues? I believe not. Our botanical colleagues have bent over backwards in acceding to our wishes.
- Herein lies my major objection to formation of a new mycological Code: I firmly believe that there are far too few fungal nomenclaturalists who are willing to devote their time and effort not only to establishing a new Code, but in publishing and revising such a Code. Within the botanical community we have a far greater number of nomenclaturalists on whose knowledge and wisdom we rely. Time after time they have continued to help us with our problems. We would, I'm sure, lose that cooperation if we were to ask them to help us out with "our" Code, while they are happy to make sure that if they help revising "their" Code they also can make sure that the special features proposed for fungi do not adversely affect any other botanical groups.

- Perhaps those proposing a new Code do not have a historical memory of what happened in the 1904 to 1910 period, when the then operative International Botanical Code met opposition by a largely US contingent of attendees at the International Botanical Congresses in those years. This led to the formulation of a separate “AMERICAN CODE OF BOTANICAL NOMENCLATURE,” primarily differing in provisions concerning typification of names. Even as late as 1942 (e.g., Seaver 1942) we had some authors following the American Code and some the International Code, with distinctly differing results in the names that were applied. I can easily foresee similar decades during which some mycologists would continue to follow the Botanical Code, with another group following a Mycological Code. A worse nightmare I do not wish to imagine.
- Will those who work with the group mycologists called “Oomycetes” that is clearly a plant lineage, not a fungal one, choose to follow a Botanical Code or a new Mycological Code? Some textbooks now actually exclude these organisms from “fungi” on evolutionary grounds, despite the fact that it is only mycologists who work with these, not botanists, nor zoologists. The pragmatic solution is that everything mycologists study are fungi, despite their phylogenetic lineage as plants or animals (e.g., mycetozoa). Unrealistic is the word that best covers the establishment of a separate MYCOLOGICAL CODE OF NOMENCLATURE. Many of my closest colleagues have argued on one or the other side of this issue. I understand their concerns, and wish I could please them all. The title of this paper expresses what I consider the crux of the solution. And the answer must be a resounding “no.”

Acknowledgments

The advice and counsel of Drs. Scott Redhead and Keith Seifert is deeply appreciated.

Literature cited

- Korf, RP. 1952. A monograph of the *Arachnopezizeae*. *Lloydia* 14: 129-180. (1951.)
- Hawksworth DL, Crous PW, Dianese JC, Gryzenhout M, Norvell LL, Seifert KA. 2009. Proposals 016–020 to amend the International Code of Botanical Nomenclature. *Mycotaxon* 108: 1-4.
- Redhead, SA, Kirk PM, Keeling PJ, Weiss LM. Proposals 048–051 to amend the International Code of Botanical Nomenclature. *Mycotaxon* 108: 505-507.
- Seaver, FJ. 1942. *The North American Cup-Fungi (Operculates)*, rev. ed. New York.

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BOOK REVIEWS AND NOTICES

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GENERAL

Ainsworth & Bisby's dictionary of the fungi. Edited by Paul M. Kirk, Paul F. Cannon, David W. Minter & Joost A. Stalpers. 2008. 10th edn. CAB International, Nosworthy Way, Wallingford, Oxon OX10 8DE, UK <orders@cabi.org>. Pp. xi + 771, figs 34, tables 4. ISBN 978-085199-826-8. Price £ 70, US \$ 149, 110 €.

In reviewing the ninth edition of the *DICTIONARY*, published in 2001, Korf (*MYCOTAXON* 82: 475, 2002) commented: “None of us can afford not to have a copy of this book at arm’s length.” Is it necessary to say more for the Bible of mycology? This *DICTIONARY* was first published in 1943, a direct result of Geoffrey Ainsworth and Guy Bisby’s nightly wartime fire-watching duties at the then Imperial Mycological Institute at Kew, and recounted in more detail by Ainsworth in his Preface to the seventh edition of 1983 – the first to be produced from a computerized database. The 360-page 2 cm thick pocket-sized book of 1943 has now swelled to a doorstep-like tome, with pages almost twice the size and a thickness of 5½ cm. Its production has also involved an expanding number of mycologists, now 45 in addition to the four editors (but ten fewer than in the eighth edition of 1995). But if you own a copy of the eighth or ninth, should every mycologist buy this one as well? For the new edition the answer has to be resoundingly positive, as this is the first to start to fully reflect the spectacular advancement made in our understanding of fungal relationships through molecular phylogenetics. Pleasingly, it still treats all organisms studied by mycologists, my personal definition of “fungi”. However, the chromistan and protozoan fungal group entries are somewhat irritatingly now relegated

¹ Books for consideration for coverage in this column should in future be mailed to my successor as Book Review Editor for *MYCOTAXON*, Else C Vellinga, at 861 Keeler Avenue, Berkeley, CA 94708-1323, USA <ecvellinga@comcast.net>. All unsigned entries in this current instalment, however, are by myself.

to separate listings at the back – meaning that the user needs to know a genus' affinity to decide where to look for its entry. In this tenth edition a particular effort has been made to add additional biographical entries to enhance the international outlook of the work, as well as including genera and higher taxa described since the last edition; many of the individual entries have also been updated. However, in the Preface it is noted that limited resources precluded the updating of essay-type entries, which has been “incomplete and imperfect”, and some now bear health-warnings to draw attention to that. There is also no systematic listing of genera by order and family as in the previous two editions, and the (admittedly imperfect) key to families last seen in the eighth of 1995 has not returned. Indeed, the editors raise the issue of whether a key to families can be constructed when so much of the higher phylogeny is increasingly molecularly defined. At least, diagnoses of the accepted families and higher taxa are provided, with four family names validated here (on p. x, and without MycoBank numbers): *Gallaceaceae*, *Helicobasidiaceae*, *Sclerogastraceae*, and *Trappeaceae*. Surprisingly, and many would consider inappropriately for a dictionary, the new generic name *Naumovoxyma* is also introduced as a replacement for *Naumovia* Kurtzman 2003 (non Dobrozr. 1928), with two combinations into it made.

The number of accepted members of the kingdom *Fungi* is now given as 75 337 genera and 97 330 species (p. 474), a substantial jump from the 80 602 species given in the 2001 edition. But, as the editors acknowledge, these figures are both likely to be an overestimates as they are derived by upwards addition for entries without making allowances for a synonymy level of 2.5:1 or possible double-counting of separately named anamorphs. In reality, however, there may well be 100-120,000 described good species, but they reside amongst the “orphans” not assigned to currently accepted genera totaled here. The front cover of the new edition, as the ninth, just has “DICTIONARY OF THE FUNGI” as the title, while the title pages have “AINSWORTH & BISBY'S DICTIONARY OF THE FUNGI”. This last title was introduced by Geoffrey Ainsworth for the fifth edition of 1961, following the death of Bisby in 1958, and has been maintained since. However, using only the shortened title on the cover has inevitably led to the correct title not be cited in the reference lists of publications.

There are a few line figures scattered through the text, as in the previous two editions, but it seems there must have been some re-ordering as they are not numbered sequentially, with Fig. 34 on p. 632 and Fig. 24 on p. 690!

Now with “more than 21,000 entries”, according to the back cover, it would be invidious to criticize individual ones, though it would have been good to have the spelling of “Stramenopiles” corrected to “Straminopiles” in Fig. 31. Having had a personal hand in the 1971, 1983, and 1995 editions, I guess I am aware more than most of the practical problems and hard work involved in

preparing editions of this work. However, as Geoffrey Ainsworth remarked to me when the 1983 edition appeared, we had cleaned up many former errors but also introduced new ones. As first commented in the 1995 edition (not the 2001 one as stated in the Preface!), it will continue to be “a marvelously imperfect work needed by all”. But having reached its 65th, should the DICTIONARY now be “retired”? In the Preface the editors proclaim that this “may well be the last ‘ink-on-paper’ version” but also note that any next edition would be produced after the current editors have all retired from full-time employment. While I personally find hard-copy books quicker to search for information than online databases and would be very sad if this were the last one for the DICTIONARY, it is the availability of compilers more than the information delivery method that I see as the greater problem. Even as the proofs were arriving, the scanning of incoming world literature and making notes and corrections for the next edition commenced used to be the normal practice at the Institute – plans for at least the data capture aspect for any possible eleventh edition need to be put into place now, if this has not been done already. If not, mycology will be in danger of losing its Bible.

Schimmelpilze und deren Bestimmung. By Liliane E. Petrini & Orlando Petrini. 2008. 2nd edn. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstrasse 3A, D-70176 Stuttgart, Germany <mail@schweizerbart.de>. Pp. vii + 147, figs 28, tables 9. [BIBLIOTHECA MYCOLOGICA no. 204.] ISBN 978-3-443-59106-9. Price 38 €.

The first edition of this introduction to the identification of mould genera was issued in 2002 (see MYCOTAXON 86: 480–481, 2003) where the reviewer commented that “the main potential . . . clearly lies in the fact that it is written in German.” This is also true for this new edition, in which very little has been changed. The overall length and all but a handful of pages are identical, and, remarkably, even the price is the same. The only significant change appears to be a modification of the key on p. 52 to include an extra couplet to separate *Monascus* and *Xeromyces* anamorphs from *Trichothecium*, which has a knock-on effect in the numbering of couplets that continues to p. 56. The latest reference in the “Literatur” is from 2002; however I did find a “Gams 2006” and “Samson et al. 2004” cited in the text (p. 99) but these were not added to “Literatur”. It is most unfortunate that the chance was not taken to update the classification and to see “Deuteromycetes” perpetuated as a main heading, correct typographical errors from the first printing, and to use uncorrected author citations: for example, *Aspergillus* should be attributed to “P. Micheli ex Link” not “Mich. : Fr.”, *Rhizopus* to “Ehrenb.” not “Ehrenb. ex Corda”, and *Thamnidium* to “Link” not “Link ex Wallr.” Sadly, such errors are likely to be perpetuated – when (in my view) they would have been better omitted throughout, as this is not a

taxonomic work but merely an identification guide. A positive point, however, is that many of the photomicrographs have evidently benefited from improved digital technology and now have heightened contrast. If there is some need for a guide in German to genera of moulds, it would have been better to completely revise this work rather than re-issue what is little more than a straight reprint. As the authors are both distinguished mycologists with excellent reputations, I am confident that they could have produced a book that was more authoritative and reflected our current knowledge of mould fungi rather than that of the later decades of the 20th century.

Forest fungi of central India. By R.K. Verma, Nidhi Sharma. K.K. Soni & Jamaluddin. 2008. International Book Distributing, Khushnuma Complex Basement, 7 Meerabai Marg (behind Jawahar Bhawan), Lucknow 226 001, U. P., India <ibdco@airtelbroadband.in>. Pp. 418, figs 503, tables 3. ISBN 81-8189-338-3. Price Rs 2100.

When I first saw this title, I assumed that it must be devoted exclusively to macromycetes, but was pleased to find it endeavoured to “compile all fungi occurring in forest of Madhya Pradesh and Chattisgarh” states (p. iii). This is a most welcome initiative of the Tropical Forest Research Institute in Jabalpur and treats 269 species, of which only 65 are basidiomycetes. This total came from field collections made at just 15 sites, and also soil isolations; just how many times these sites were visited and at what times of the year is not stated. The result can therefore be but a snapshot rather than a full inventory. Indeed, such a number must surely represent well under 10 % of the fungi actually present in the area covered. At least the authors are evidently aware of the real extent of fungal diversity, as they comment that “of the estimated 6 million fungi only 405.7 thousand have been catalogued” (p. 1) – a statement that is unreferenced and one in which I would have to question both figures on the current information analyses I am aware of. However, while the number of species covered may be modest, almost half (133 taxa) are of especial interest. Two new genera are described (*Acrodictyiella* for a dematiaceous hyphomycetes, and *Kamalomyces* in *Tubeufiaceae*) as are 22 new species, 31 species newly recorded for India, and 98 species with new host records. The identifications and recognition of new taxa seem to have been based on published literature (pp. 8–9) rather than by consulting national and international specialists. This is commendable in one respect, and Dr Verma in particular has previously described many new fungi from India, but this makes me worry how many of the new taxa will stand up to more critical scrutiny over time — particularly as some are placed in very speciose genera such as *Acremonium*, *Corynespora*, *Hypoxylon*, *Phyllachora*, *Pseudocercospora*, and *Pseudospiropes*. It would have been preferable to publish the new taxa separately in peer-reviewed journals, which would also have

made them more accessible to mycologists in general; perhaps the authors can be encouraged to deposit information on these in MycoBank now they have appeared (no MycoBank numbers are listed in the accounts).

Irritatingly, the species are arranged in a systematic rather than an alphabetical system by order, but this is more than compensated for by the information on places of publication and synonyms, detailed descriptions, information on hosts, details of collections examined, notes on occurrences outside India, and especially illustrations that include many of infected host leaves as well as line drawings and photomicrographs. Some of the host photographs are in colour, as is a portrait of Kamal, teacher of — and I am sure an inspiration to — the first two authors of the volume. Following the species accounts, there are tables summarizing the records both “forest wise” and “treewise” — the latter including 161 tree species — a bibliography, and index to fungus names.

Overall, this book cannot but be considered a major contribution to our knowledge of the mycobiota of the region. It is also no mean achievement for the authors to have produced this largely unaided, even though that potentially has a downside; I fear that this will increasingly be the case as the numbers of taxonomic mycologists in the west continue to decline. The book will be of value for ecologists, foresters, and pathologists as well as mycologists endeavouring to identify fungi from the forests of central India, and will also be required by systematic mycology libraries generally in view of the newly described taxa it contains.

Hongos de parques y jardines y sus relaciones con la gente. By Gastón Guzmán. 2008. Secretaría de Educación de Veracruz, km 4.5 Carretera Federal Xalapa-Veracruz, C. P. 91190 Xalapa, Veracruz, México. Pp. 242, col. figs 366. ISBN 978-970-670-170-1. Price not indicated.

The issue of gardens and wildlife has assumed a heightened awareness in the UK over the last few years, leading to the publication of several books and a Wildlife Gardening Forum that runs scientific meetings. It therefore came as something of a surprise to find that Mexico was already ahead in this game, at least as regards fungi, but I am sure this is largely a result of Gastón's campaigning. Entirely in Spanish, the first 40 pages address a series of questions that might be expected from the general public, such as: Are there very poisonous fungi in a park or garden?, What is fungus and how do you study them?, and What is the difference between edible and poisonous fungi? There are also pages on the importance of knowing about fungi, types of poisoning, and how to collect and preserve them. Children and young people feature strongly in the colour photographs illustrating these first sections. The heart of the book, however, comprises information on around 125 fungi. Each individual species, or sometimes genus, has at least one, and in some cases two, full pages with symbols

indicating edibility, toxicity, hallucinogenic nature (with stars!), or medical uses — with large colour photographs dominating. The systematic coverage is wide-ranging, and I was gratified to see some lichens included. The work ends with a rather full glossary, a list of recommended books, an index to Mexican common names, and another question: How many fungi are there in Mexico and how many of these are hallucinogenic? He estimates 200,000, discusses the initiation of Wasson into Mexican hallucinogenic mushrooms he arranged in 1953, and indicates that 50 are known in Mexico and South America compared with about 15 in the USA and 10 in Europe. It is great to see Gastón, 77 years old this year, still so actively promoting the public understanding of fungi and clearly getting the message through to the state authorities and convincing them to publish such a work.

Gljive Srbije i zapadnog Balkana [Fungi of Serbia and the Balkans]. By Branislav Uzelac. 2009. BGV Logik, Crvenih Hrastova, Cerak, 11030 Beograd, Serbia <english@glijvari.org.rs> or <goran.milosevic@poducavanje.co.rs>. Pp. 464, col. photographs *ca* 1200. ISBN 978-86-912677-0-4. Price 120 €.

This beautiful book, entirely in Serbian apart from the Foreword by Ann Pringle (Harvard University) and Acknowledgements, covers all major macromycetes found in Serbia and the western Balkans. The author is a well-known natural history TV-presenter and scientific writer in Serbia who previously prepared *JESTIVE GLIJVEI I LIŠAJEVI [EDIBLE FUNGI AND LICHENS]* in 2006 (a book that I have not seen). He is also the founder and President of the Mycologist's Association of Serbia and has been working on this guide along with his Association colleagues since 2003. It starts with a 21-page overview of what fungi are and their overall classification, stressing their position with respect to other kingdoms and introducing aspects of life-cycles, ecology, identification, edibility, cultivation, poison syndromes, and value as bioindicators. Almost the whole of the remaining book is devoted to species, and covers over 1500, of which around 1200 are illustrated in superb colour; apart from 102 ascomycetes, all those illustrated are basidiomycetes. These are preceded not by any formal key but by a series of 22 annotated boxed colour illustrations that directs the user to particular page-spans – a pragmatic approach I do not recall having seen used before in such a work and I am sure will help a great deal.

The species are arranged in a modern phylogenetic system by orders and families (sometimes grouped together) and also within them, which complicates locating particular taxa without recourse to the index. There are three species per page in a double-column format in which the inner columns have the text and the outer the photographs. This is very user-friendly and is almost identical to that in the *ENCYCLOPEDIA OF FUNGI* (Jordan 2004). The text has the accepted name and author citation, ordinal placement, selected synonyms,

sometimes a Serbian name, and information on morphology, microscopic features, chemical reactions, edibility, habitat, and distribution, sometimes with additional comments as well. The selection of species also includes photographs of some that are rarely illustrated, such as *Amanita velosa*, *Rickenella mellea*, and *Xerocomus persicolor*. The book finishes with a glossary, indices to scientific and Serbian names, and four pages of references.

Of course there are slips, such as the spelling “*Corficiales*” for “*Corticiales*” (p. 71), and a misunderstanding over the use of the colon in citations as in *Tubaria hiemalis* “Romagnesi : Bon” rather than “Romagnesi ex Bon” (p. 351). And I am sure some macrofungal specialists would argue as to whether the species in all photographs were correctly identified. But these minutiae do not detract from the quality of the coloured images that make the volume a joy to leaf-through. This will be major stimulus to field mycology in the region, something recognized by the financial contributions towards the cost of publication received from Roger Phillips personally, the New Phytologist Trust, and three Serbian agencies. I understand that the possibility of a version in English is being explored, but in case that proves impractical, if you want a copy it should be ordered promptly as only 1000 copies have been printed and these will be much in demand in the region!

Jordan M (2004) THE ENCYCLOPEDIA OF FUNGI OF BRITAIN AND EUROPE. London: Frances Lincoln.

A preliminary checklist of micromycetes in Poland. Edited by Wiesław Mułenko, Tomasz Majewski & Małgorzata Ruszkiewicz-Michalska. 2008. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland <ed-office@ib-pan.krakow.pl>. Pp. 752. [BIODIVERSITY OF POLAND no. 9.] ISBN 978-83-89648-75-4. Price 74 €.

Earlier volumes in this series have covered the larger basidiomycetes (see MYCOTAXON 94: 379-380, 2005), larger ascomycetes (102: 446, 2007), lichens and lichenicolous fungi (94: 387, 2005), and slime moulds (90: 235-236, 2004). This new volume covers all other fungal groups, including other ascomycetes and basidiomycetes, chytrids, glomeromycetes, hypochytrids, oomycetes, plasmodiophoromycetes, and zygomycetes along with conidial fungi. It has no fewer than 16 contributors, and the genera or other groups they have been responsible for are detailed (p. 6); it is consequently very much a national effort. The species are treated alphabetically within phyla and orders, and for each there is information on the substratum (including hosts) and references to the literature reporting them (selected in the case of especially common fungi). In only exceptional cases are there commenting notes. Synonyms are included in the alphabetical sequences and cross-referenced to the accepted names, a commendable and economical way to present this information, which means

that only genera needed to be included in the final index. This somewhat utilitarian treatment was unavoidable if a manageable volume were to be produced, as an impressive 5969 species are covered, of which by far the largest groups are the hyphomycetes (1574 species) and coelomycetes (1628 species). Yet the editors realize they are still far from a complete checklist of these groups, hence the “preliminary” in the title. In addition to as yet undiscovered taxa, they also note that much applied Polish mycological literature in particular has still to be searched. This may not be definitive, but it is a commendable overview and quick-reference to which of these fungi are known from the country, which will be of value both to mycologists and plant pathologists. Also, while the bibliographic searching may not have been as thorough as the editors would considered ideal, the reference list included nevertheless does occupy 53 pages and so provides an important entry-point into the Polish microfungi literature.

Diversity, ecology, and conservation of truffle fungi in forests of the Pacific Northwest. By James M. Trappe, Randy Molina, Daniel L. Luoma, Efren Cázares, David Pilz, Jane E. Smith, Michael A. Castellano, Steven L. Miller & Matthew J. Trappe. 2009. US Department of Agriculture Forest Service, Pacific Northwest Research Station, 333 SW First Avenue, P. O. Box 3890, Portland, OR 97208-3890, USA <pnw_pnwpubs@fs.fed.us>. Pp. 194, figs 91, tables 4, CD. [GENERAL TECHNICAL REPORT no. PNW-GTR-772.] ISBN not indicated. Price not indicated.

The abstract proclaims the Pacific Northwest has been an epicentre for the evolution of truffles. With 350 species dispersed through 55 genera, there would certainly be no current contenders, although southeast Australia may eventually prove to be a rival. It is pleasing to see the USDA Forest Service continuing to support mycological survey and conservation, but this report covers much more than that. The introductory sections cover the nature of truffles, where they occur, and a history of truffle science in the Pacific Northwest that has biographical notes and portraits of key players from Vittadini through Gilkey and Harkness to modern times and including Trappe, Molina, and Castellano. There follow remarks on truffle evolution as revealed by molecular phylogenetics, discussion of the “secotoid syndrome” (i.e. the now well-established evolution of hypogeous fruiting bodies from epigeous ancestors), and a biogeographical analysis. A table demonstrates the present ranges and inferred origins of the genera present in the Pacific Northwest. The thorny issue of nomenclature is addressed, and the problems and solutions are illustrated by the protracted history of *Schenella simplex*, originally described as a slime mould but now recognized as representing a separate family of basidiomycete truffles in the *Geastrales*.

Following an outline classification showing the various genera assigned to family is a description of the genera. These are arranged alphabetically, and each has a full page with information on the etymology, characters, number of species, distribution, seasonality, references to keys and descriptions, comments, and a coloured photograph showing both intact and sliced sporocarps. No illustrations or photomicrographs are included, which was disappointing to me as so many of these fungi have such wonderful spores. There is a series of four keys to the genera, but as this work is not intended as a comprehensive identification guide, there are no keys to species. However, the CD inside the back cover has fine macrophotographs of 111 species, as well as a movie “A truffle hunt with Jim Trappe,” showing him in action with his special truffle rake.

This book could be seen as a series of courses in a menu, and the next continues to delight. Entitled “Ecology of truffles”, it has the best coloured shots of mycorrhizal roots sheathed by truffle fungi that I have seen in print, some from synthesis cultures and others from nature. The authors stress that, compared to ectomycorrhizal mushrooms, these fungi typically display narrow host ranges – often to a single host genus, such as *Alpova diplophloeus*, which is evidently restricted to *Alnus*. The importance of truffles in ecosystem processes is discussed in relation to nutrient cycling and soil structure, mycorrhizal networks, soil food webs, and small mammal mycophagy. The mycophagy can be obligate, preferential, or casual, but is documented here for no less than 45 mammals and birds in the Pacific Northwest, including bears, chipmunks, goats, gophers, jays, marmots, voles, and even the high-profile Northern spotted owl. If you need examples to help sell the importance of fungi in the conservation arena, there is no shortage of striking examples here. Following discussion of the effects of different silvicultural practices, implications for wildlife, and inoculation procedures, the next course is on gastronomy with tempting dishes displayed, and naturally leads to cultivation in plantations and the conservation of natural resources. The dessert is a 3½ page summary of 12 principles of management practices and considerations that merit promulgation throughout the conservation and forestry audiences, and I trust this will be given a wider circulation than in this one report.

This is splendid work that all fungal conservationists could read with benefit to “provide the underpinning for conserving this fascinating and important group of forest organisms” (p. 164). There is no price indicated, but somewhat dauntingly the back cover bears the warning: “Penalty for private use, \$300.” I do hope that should be interpreted as meaning that if you do receive or otherwise obtain a copy, you risk a fine for not sharing the information it contains!

Field guide to North American truffles: hunting, identifying, and enjoying the world's most prized fungi. By Matt Trappe, Frank Evans & James Trappe. 2007. Ten Speed Press, P. O. Box 7123, Berkeley, CA 94707, USA <www.tenspeed.com>. Pp. 136, figs in colour. ISBN 978-1-58008-862-6. Price US \$ 16.95.

This is a real pocket-sized guide, dealing with 90 species. Following a poignant 19-page introduction designed for the general naturalist, each species is conveniently treated alphabetically on a separate page. In addition to information on the systematic position, season, distribution, habitat, spores, features, and palatability are colour photographs of sliced and unsliced sporocarps — supplemented in most cases by the photomicrographs of ascospores I missed in the Forest Service Report reviewed above. Much of the data has been contributed by members of the North American Truffling Society (NATS) from their personal field knowledge of these fungi. On the back cover, Paul Stamets comments, “An amazing accomplishment – this is the best field guide to truffles ever published!” It is clear all North American field mycologists should have a copy.

OOMYCETES

***Phytophthora*: Identifying species by morphology and DNA fingerprints.** By Mannon E. Gallegly and Chuanxue Hong. 2008. APS Press, American Phytopathological Society, 340 Pilot Knob Road, Saint Paul, MN 55121, USA; <aps@scisoc.org>. Pp. 168, figs 130. ISBN 978-0-89054-364-1. Price US \$ 79.

Phytophthora remains a serious threat to the health of plants worldwide, yet species identification is challenging, even for *Phytophthora* specialists. This spiral-bound book will thus be a welcome addition to the bookshelf (or laboratory bench) of those involved in identifying isolates to species. This practical guide culminates a lengthy study in which the authors have assembled isolates of nearly 60 species from which they have developed an effective morphological key combined with a method of DNA-based fingerprinting. The work nicely complements the seminal MYCOLOGICAL PAPERS produced at the former International Mycological Institute, and the detailed text by Erwin and Ribeiro published by the APS in 1996.

Undoubtedly the authors have taken the correct approach in combining molecular and morphological methods to identify each species, and this rigour is a major strength. The double-page format for each species is a success with much data presented clearly and succinctly at a level of detail appropriate to the book's objectives (i.e. a practical guide to species identification). Their two keys well complement each other to clearly delineate most of the examined species.

However, no key is perfect, and, as acknowledged by the authors, there are several challenges. A perennial one is keeping such reference works up to date

given the pace of discovery in the genus. Inevitably, many recently described *Phytophthora* species are missing, and updated editions or even web-based supplements would thus be welcome. It is also noted that the SSCP method for analysing the sequence variation in the ITS regions has limitations. Improved availability and reductions in price are turning laboratories to DNA sequencing as the method of choice. Sequencing provides the ultimate base-by-base resolution, and is pretty straightforward and rapid to run compared to restriction enzyme digestion or SSCP. Matching SSCP fingerprints is also challenging; ideally the fingerprint profile of the unknown isolate should be run directly alongside that of suitable reference strains, which may not be available in the user's laboratory. By comparison, a DNA sequence may be readily matched to the very large databases via BLAST sequence similarity methods. Lastly, there are clearly problematic taxa where no key or single method will provide a definitive identity. A range of undescribed taxa within ITS clade 6 have, for example, been reported. Many of these are considered sterile and a key that depends upon morphological features of the sexual structures will obviously fail to identify such taxa. Sequence variation within defined morphospecies will also be a problem as acknowledged in *P. cryptogea*, *P. megasperma*, and *P. citricola*. Some of these taxonomic inconsistencies have been, or are in the process of being, unraveled and any new editions will need to acknowledge this progress.

Other quibbles: Descriptions or images of the colony morphology on standard growth media and reference to the ITS sequences (where known) would have been helpful. The authors assert that the pictures are simply to "show the morphology . . . with no attempt to show the fine details", but it is a pity that the quality of the micrographs is not higher. Lastly, it is surprising that the micrographs of "definitive morphological characters" do not include examples of amphigynous and paragynous antheridia.

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BASIDIOMYCETES

Funga Nordica: agaricoid, boletoid and cyphelloid genera. Edited by Henning Knudsen & Jan Vesterholt. 2008. Nordsvamp, c/o Botanical Museum, Gothersgade 130, DK-1123 Copenhagen, Denmark. Pp. 965, figs, DVD. ISBN 978-87-983961-3-0. Price 99-119 €, £ 75-106, US \$ 148-176.

This work is surely destined to become THE work for the identification of northern European mushrooms for decades to come. It represents a herculean effort involving 41 mycologists from 16 countries and covers 2675 species from

the Nordic countries, plus another 114 known from neighbouring ones that might be expected in the Nordic area. Following introductory sections on the methodology used, vegetation zones and provinces, abbreviations employed for characters and references to illustrations, and a glossary (with most useful line drawings on the terminology for spore and cystidium shapes), are the all-important keys to genera. There are seven main keys based on easily recognized features such as fruit body types, hymenium types, and spore deposit colour – and then one to the orders covered. The arrangement is then by order, family, and genus, arranged by order and family and not alphabetically. I found — and I am sure many users will find — this most frustrating, necessitating repeated reference to the inside back cover that does list the pages on which individual genera are to be found. Preferably keys to families, and then genera, could have been collected together, and even a synoptic classification presented over one or two pages, but with the genera still treated alphabetically as is done in *THE LICHENS OF GREAT BRITAIN AND IRELAND* (reviewed below). Another pragmatic refinement to consider for a future edition would be the inclusion of backtracking numbers in parentheses after couplet numbers in the keys, something I always find helpful in endeavouring to determine where I went wrong when the trail leads to a most unlikely taxon!

The bulk of the work comprises descriptions of families and genera, and then keys to the species with a treasure-chest of information where they are keyed out. In addition to morphological and anatomical details necessary for a correct diagnosis, there is information on ecology, distribution, conservation status in particular countries (using IUCN categories), references to selected colour illustrations, and synonyms given in parentheses. The issue of edibility is probably wisely avoided, but poisonous or hallucinogenic species are flagged. Author citations of scientific names are provided throughout, but with no reference to the place of publication or even the year of the work; at least the latter would have been helpful, though information on both authors and dates is no longer as useful as was formerly the case as this information is now available online and free from the INDEX FUNGORUM database.

Illustrations in the text are limited to line-drawings of critical features, but that is more than compensated for by the DVD attached to the inside back cover which has over 4000 coloured images, as well as PDF versions of the keys, in a new version (3.1) of MYCOKEY (version 2.1 is reviewed in MYCOTAXON 102: 434-5, 2007). Species featured on the DVD are indicated by a symbol of concentric rings at the end of the text where they are keyed out.

The accounts are very much at the cutting edge of mushroom taxonomy, with both very recently described species and some names even in press. The latter include the new family name *Chromocyphellaceae* cited as “Knudsen in press” with a reference to “Petersen, Knudsen & Seberg (in press)”, but that work

is not listed in the 20 pages of references compiled near the end of the book. Critical notes on six species are presented separately, and 14 new combinations are made (but sadly not with MycoBank reference numbers). As I am not a specialist of basidiomycete taxonomy, but rather a consumer of the results, it would be invidious of me to comment on particular changes in names at generic or species levels except to say that some re-learning will be occasioned. The main text concludes by an index of scientific names arranged by genus and species, but not one by species epithet alone that would have been helpful as a short cut for users such as myself behind with agaric redispositions.

On a separate point, I was intrigued to see the use of “*Funga*” in the title as a term equivalent to “*Flora*” but for fungi. As far as I am aware, “funga” was first used in this sense in Gravesen (2000), and for me it is to be preferred to “mycota” as the latter term implies a phylum and so diminishes the hierarchical standing of the organisms – although “mycobiota” is perhaps more self-explanatory to non-mycologists and so might be preferred (Hawksworth 2000).

A remarkable achievement, especially as the project only “took off” in January 2006 with the goal of completion within two years (p. 11), on which all involved merit the heartiest congratulations. This book, complementing Horak’s (2005; reviewed in MYCOTAXON 96: 336, 2006) keys to the central European species, now empowers “amateur” mycologists throughout Europe as never before to name so many of the fungi they collect but previously could not locate in the plethora of field guides. No macromycetologist should be without a copy, but do shop-around as advertised prices vary considerably!

Gravesen S, 2000. Microbiology on Indoor Air ‘99 – what is new and interesting? An overview of selected papers presented in Edinburgh, August 1999. INDOOR AIR 10: 74-80.

Hawksworth DL, 2000. Mycobiota, mycota or funga? MYCOLOGICAL RESEARCH 104: 1283.

Horak E, 2005. RÖHRLINGE UND BLÄTTERPILZE IN EUROPA. Heidelberg: Elsevier Spektrum Akademischer Verlag.

Torikseened Soomes ja Eestis. By Tuomo Niemelä. 2008. [Translated by Erast Parmasto.] Eesti Loodusfoto, Tartu, Estonia. Pp. 320, col. figs 301. ISBN 978-87-9985-830-86-4. Price not indicated.

This book on the pore fungi of Finland and Estonia is a translation in Estonian of Niemelä’s KÄÄVÄT, PUIDEN SIENET, which was published as a number of NORRLINIA in Finnish in 2005; sadly it was missed by MYCOTAXON at the time. The original book covered 230 species known in Finland, plus 11 found in neighbouring areas of Estonia and Sweden. In making the translation, Erast has reduced the information on distribution and ecology in Finland and added information on the 211 species occurring in Estonia, with Niemelä adding photographs of four Estonian species. The coloured photographs are superb, and it is pleasing to see the vouchers for all clearly indicated in the figure legends. Short descriptions and keys are provided, but there are no drawings

or photographs of microscopic features. Even though this is in Estonian, it will be a boon to all wishing to name polypores in the region. The translation was made possible by a grant from the Estonian Environmental Investment Centre, and Erast writes that about a third of the print run was being distributed free of charge to staff and students in Estonian universities, forest pathologists, nature conservationists, and amateur mycologists. Erast further comments that “thanks to the possibility to have such a translation, I spared some years of my life: otherwise I had to compile [a] similar book (as I had promised many years), surely not better than Tuomo’s one”. What better recommendation could there be than that?!

Pilzkompedium. Band 2. By Erhard Ludwig. 2007. Fungicon-Verlag, Saalower Straße 42, D-12307 Berlin, Germany; <erhardludwig@GMX.de>. Pp. 723 (text volume) + plates 205 (plates volume). ISBN 978-3-940316-01-1 (text); 978-3-940316-00-4 (plates). Price 72 € (text) + 138 € (plates).

This is the second part of a *magnum opus* aiming to illustrate and describe all the European agarics (plus some other macrofungi) in twelve volumes. This would be a major challenge for a well-funded consortium of mycologists, but Erhard Ludwig is writing, painting, and publishing the whole series himself. To tackle such a project on one’s own is a remarkable achievement. To tackle it successfully is simply astonishing.

Each part consists of a volume of text together with a large-format (34 x 24 cm) volume of coloured plates. The first part, published in 2001 (and not received for review by MYCOTAXON) dealt with 89 small genera of agarics and has proved extremely useful as a convenient first source of information on these often neglected species. An unfamiliar agaric found in England in 2008 was, for example, quickly tracked down to the genus *Callistosporium* (not previously known in Britain) thanks to *Pilzkompedium*.

This second part is subtitled ‘The larger genera of *Agaricales* with coloured spores (except *Cortinariaceae*)’ and as such deals with *Agaricus* (plus *Allopsalliota*), *Conocybe*, *Coprinus* (inclusive of *Coprinellus*, *Coprinopsis*, and *Parasola*), *Entoloma*, *Lacrymaria*, *Pholiotina*, *Pluteus*, and *Psathyrella*. Altogether, 547 species are illustrated and described.

The text is in German, but each taxon entry starts with a brief English summary. Separate paragraphs then note macro- and microscopic characters, similar species, literature references, and details of the collections pictured. Line drawings illustrate microscopic details. An abbreviated key (leading one to groups of taxa, rather than individual species) is provided for each genus.

The plates are impressive and beautifully produced. Watercolour paintings of fungi can often be amateurish in the worst sense – flat, over-stylized, or oddly coloured. But Erhard Ludwig is an excellent illustrator and his artwork is lifelike

and convincing. Each taxon is illustrated by a range of specimens shown life-size or larger and often taken from two or more collections. *Agaricus subperonatus*, for example, is illustrated by 14 specimens from four collections, enabling the author to show variations in colour, size, and form; *Entoloma cetratum* is illustrated by more than 30 specimens from eight collections. All are clearly cross-referenced to collection data in the text volume. Most of the watercolours are painted from life – the result of extensive foraging going back at least 30 years. Some, however, are based on original or published photographs.

Surprisingly, no fewer than 33 new taxa (species, varieties, and forms) are described in the text, with additional taxa (some as yet unnamed) provisionally described. The author notes that several specialists, including A. Hausknecht and M. E. Noordeloos, have been consulted – indeed some of the new *Entoloma* taxa are jointly described with the latter author – but this still seems an awful lot of novelties for a non-molecular study in a mycobiota that is comparatively well-known. It might have been better to have published the new taxa in a peer-reviewed journal, particularly since the cost of these two volumes may put them beyond the reach of many individual mycologists.

Despite (or perhaps because of) the high price tag, these are handsome volumes, extremely well illustrated, and thoroughly documented. If you can afford them, buy them. They will certainly bring you a great deal of pleasure.

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Annotated list of polypores for the Iberian Peninsula and Balearic Islands. By I. Melo, J. Cardoso & M.T. Telleria. 2007. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany <mail@schweizerbart.de>. Pp. 183, figs 1. [BIBLIOTHECA MYCOLOGICA no. 203.] ISBN 978-3-443-59105-2. Price 54 €.

This checklist embraces the names of all polypores reported from the region, but is far more than a naked list. For each species, which are listed alphabetically, information is given on places of publication of the names and synonyms, the types, distribution down to the level of provinces, substrata (with tree species named), and collections in the region holding material of the taxon. There is also a substantial 44 pages of “bibliography surveyed” in compiling the checklist in addition to eight of works cited, and a comprehensive index by epithet. Sadly, the work is marred for me by a failure to understand the bibliographic references and dates to be accorded to sanctioned fungal names. For example, “*Polyporus ulmarius* Sowerby: Fr.” only has the reference to the place of sanctioning, which is indicated as the basionym [!], and not to Sowerby’s original publication, where the true basionym is to be found. Also, the use of “in” in author citations does not follow the recent CODES. These may seem small points, but it is a reality that errors in standard checklists become perpetuated

though being copied into other publications and databases. Nevertheless, this work is destined to be the key reference point on the polypores of the region, and will also be of value to amateurs because of the provincial data included. The authors are to be congratulated on drawing all this information together, and it is to be hoped that it will be the spur to additional volumes on these fungi in the FLORA MICOLÓGICA IBÉRICA series.

Die Gattung *Ramaria* in Deutschland. Monografie zur Gattung *Ramaria* in Deutschland, mit Bestimmungsschlüssel zu den europäischen Arten. By Josef Christan. 2008. IHW-Verlag, Eching, Germany. Pp. 352, figs 334 (mostly coloured). ISBN 978-3-930167-71-5. Price 98 €.

The attractive species of *Ramaria* (mainly subgenus *Ramaria*) are often indicative of healthy and biodiverse habitats; they are among the first to suffer from environmental stress and so form valuable bioindicators. Thorough studies of recent decades have shown that the taxonomy of the genus is difficult and only a few specialists have been able to identify species reliably according to the scattered modern literature. Because of this, previous indications about ecology and distribution must be regarded with the utmost reservation. The publication of this comprehensive monograph for Europe was impatiently expected by the mycological community. The beautiful, thoroughly documented, and attractively produced book has finally appeared. It is undoubtedly useful for the whole of Europe, but also beyond, and not only because of the keys.

An introductory chapter of 53 pages deals with historical illustrated works, in which old plates are faithfully reproduced and critically discussed; they often serve as iconotypes of the treated species. Macroscopic and microscopic features are then exhaustively described and illustrated in good drawings. Without a microscope no reliable species identification is possible. The shape, size and ornamentation of spores, presence of clamp connections at the base of the basidia, and hyphal structures provide the most important characters. Accurate drawings of the spores are given for all species at 3500 × magnification. Among the macroscopic features, the fruit body colour that varies with age is still relevant. For an accurate characterization, besides vernacular descriptive terms, symbols from the colour codes by Küppers in DuMont's COLOUR ATLAS (1984, 1999) are given, from which only one 2-dimensional plate is reproduced at the end of the book (yellow–magenta). High quality colour photographs also provide the necessary information for each species. The taxonomic situation of the genus is dealt with on 12 pages (more extensively in ZEITSCHRIFT FÜR MYKOLOGIE 71: 7–42, 2005). Four subgenera are distinguished. The largest, *Ramaria*, with its biggest section *Formosae*, *Lentoramaria* (e.g. *R. stricta*), *Echinoramaria*, and *Asteroramaria* (with the still insufficiently resolved *R. ochraceovirens* complex). Papers dealing with DNA analyses are equally referenced, which support this

subdivision that correlates surprisingly well with micromorphological and ecological findings. *Gomphus* and *Ramaria* subgenus *Ramaria* are recognized as closest relatives, whilst the remaining subgenera are more distantly related and may eventually require generic segregation. A recent study by Hosaka et al. from the AFTOL project (MYCOLOGIA 98: 949-959, 2007) provides additional evidence for this.

Two different keys (both in German and in English) lead to the European species: Key I circumvents the taxonomic structures outlined above and leads directly to the species (and is particularly suited for beginners); while Key II first separates the subgenera and sections, and is more suited for use by advanced students who are familiar with these higher categories. The second key gives more emphasis to microscopical features.

The species known in Germany are dealt with in alphabetic sequence for each subgenus and section, each on two pages, with a full description, good colour illustrations, critical remarks on the species concept, and a brief characterization in English. The removal of lists of material examined, SEM micrographs of spores, and diagrams of spore sizes to later sections made this economical layout possible. Questions of nomenclature are also dealt with in a competent way. The perhaps surprising citation of the genus as *Ramaria* Fr. ex Bonord. (although the name is much older) is due to a conservation proposal. *Ramaria aurea* and *R. rufescens* were recognized by Fries as distinct species only in 1838, and these names are not sanctioned in SYSTEMA MYCOLOGICUM (1821-32). Conversely, the names *R. flaccida* and *R. suecica* were sanctioned by Fries. In the case of type varieties of a species, it should also be noted that the authors should be cited immediately after the species epithet, not after the varietal name.

That only very few minor details and a limited number of printing errors could be criticized testifies to the unusually high standard of this book. This is in all its parts the work of an assiduous mycological amateur, who, with close contact with professional and other mycologists specializing in this genus, has produced an admirable work, for which field mycologists will owe him thanks.

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***Phaeocollybia* of Pacific Northwest North America.** By Lorelei L. Norvell & Ronald L. Exeter. 2008. US Department of the Interior, Bureau of Land Management, Salem District, 1717 Fabry Road SE, Salem, OR 97306, USA <Ronald_Exeter@blm.gov>. Pp. 228, 440 colour photos, 25 drawings. ISBN 978-0-9791310-1-1. Price US \$ 71.

The Pacific Northwest is believed to be the most highly diverse region of the world for *Phaeocollybia* species, with 25 species recognized of which ten have

been most recently described as new to science from the region. The authors provide a world checklist listing 79 species; most of those not known in the Pacific Northwest being from elsewhere in the Americas, Australasia (17 species) or Asia (9) – with only six in Europe. However, 14 of the species had been identified as “of concern” with respect to their conservation status, and that occasioned a more detailed survey leading to this splendid regional monograph that has occupied so much of the non-editorial time of Lorelei in particular for over 15 years, in the field, herbaria, libraries, and the laboratory. So intensive has been their survey work that now no species in the region is considered “threatened or endangered”, although 13 are categorized as “rare”. The numbers of known sites in British Columbia, California, Idaho, Oregon, and Washington are tabled, with Oregon emerging as the ultimate *Phaeocollybia* treasure chest. The species are now established as being ectomycorrhizal rather than saprotrophic, primarily as a result of Lorelei’s studies. Effects of logging and forest age are discussed; while smaller patch cuts appear to result in a more rapid return to fruiting, the richest stands for these fungi were ~150-200 years old. Before the systematic treatment, there is well-illustrated survey of the developmental biology and anatomy of the genus, including a neat classification of “pseudorhizal” types, i.e. the basal downward extension or branching of the stipes that are so important in the taxonomy of this genus.

The taxonomic part starts with a detailed account of the genus, sections proposed, an unrooted molecularly-based tree showing the phylogenetic relationships between all 25 treated species, comparisons with other genera, information on macro- micro- and chemical characters, and identification procedures. The information included ranges from subtle odours such as “potato/pansy” to fluorescence under UV-light and syringaldazine reactivity – another chemical to be added to the rank of dropping bottles ranged by the microscope. The key characters of the species are summarized in a table (p. 33), and a synopsis of the accepted species, synonyms, and excluded species precedes two keys, one using all characters and the other only microscopic features. Species treatments are packed with information including nomenclature, synonyms and misapplied names, typifications, field characters, ecology, separation from similar species, often a range of colour photographs of the habit, photomicrographs, line drawings (portrayed shadowed as if on sheets straight from Lorelei’s sketch pad), and key references.

There is a complete bibliography, extensive glossary, and finally a concluding colour photograph showing Lorelei in “Oz”, an old growth Bureau of Land Management Reserve Forest in Polk County, Oregon. The authors designate this as “an official phaeocollybian Garden of Eden” as it yielded no fewer than 11 *Phaeocollybia* species. The whole is most attractively produced, with the dedication and enthusiasm of the authors for their “pets” evident

throughout. This study is also instructive in that neither of the authors is based in a university, museum, or other research institute. Lorelei is an independent professional mycologist, while Ron is a botanist in the Salem District Bureau of Land Management that published it. This monograph again demonstrates how the highest mycological standards can be achieved by dedicated unaffiliated mycologists.

As well as being a major contribution to securing the conservation of many of these fungi, this will be a delight to use in identifying *Phaeocollybia*'s worldwide, and not just in the Pacific Northwest. My only niggle is that the cover of my copy was torn on arrival; was this down to impatience when packing by the Senior Systems Administrator depicted at the foot of the last page? (i.e., one of Lorelei's cats . . . who was probably be as relieved as Lorelei and Ron to see this work in print.)

Champignons sans noms! Vol. 1. By J. Schopfer. 2006. B. Schopfer, Amselweg 5, CH 1793 Jeuss, Switzerland. Pp. 347. ISBN none given. Price not given, but around 145 CHF.

This is a rather odd, self-published book by the late John Schopfer. It effectively consists of his illustrated notes (in French) on a variety of fungi collected either locally in Switzerland or elsewhere in Europe, from Norway to France, Spain, and Italy. Some 80 basidiomycetes, mostly agarics, are featured, plus 32 ascomycetes, and eight myxomycetes. All are accompanied by photographs plus descriptions of macro- and microcharacters. Some of these fungi are tentatively named, while others are given provisional names in the hope that, perhaps, they might represent new species. At the end of the volume are some observations on the appearance of fungal sporocarps linked to phases of the moon; the author concludes that there is no meaningful correlation.

One can certainly sympathize with John Schopfer's difficulties in finding convincing names for all his collections. However, many such problems could have been solved by not attempting to identify everything single-handed. For example, the author's mysterious pink *Clavaria* species with spiny spores – here dubbed '*C. pseudorosea*' – is the '*stellifera*' morph of *C. incarnata*. But to discover this, you would need to know the specialist literature on this group of fungi or contact someone who does.

Many herbaria have unpublished notes similar to these that are extremely useful when examining specimens, and the book would certainly be of value in this context (the author appears to have retained herbarium specimens, although there is no indication where). Otherwise, it is difficult to think of a use for the volume. It is certainly well produced and the photographs are of a high standard, but the rather random mix of species, the lack of authoritative

determinations, and the comparatively high price will not endear it to potential purchasers.

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ASCOMYCETES

Taxonomy, phylogeny, and ecology of bark-inhabiting tree-pathogenic fungi in the *Cryphonectriaceae*. By Marieka Gryzenhout, Brenda D. Wingfield & Michael J. Wingfield. 2009. APS Press, American Phytopathological Society, 340 Pilot Knob Road, Saint Paul, MN 55121, USA <aps@scisoc.org>. Pp. x + 119, col. figs 14, other figs 38. ISBN 978-0-89054-367-2. Price US \$ 119.

This family includes some of the most devastating fungal pathogens of trees, most famously the causal agent of Chestnut blight (*Cryphonectria parasitica*) that spectacularly almost destroyed the American chestnut (*Castanea dentata*) in North America while seriously damaging the European chestnut (*C. sativa*) in the early 1900s. From around 1980, *Cryphonectria cubensis* and some allied species have been causing serious problems on *Eucalyptus* trees. Yet the family has only recently started to be examined critically, and this has led to the recognition of no less than nine new genera and many new species related to *Cryphonectria* and *Endothia* in the last few years as a result of careful molecular and morphological studies – especially involving the first author, and some of the results are published here for the first time. However, no synthesis of all the new information now available has previously been made.

The first 39 pages of this book focus on the diseases these fungi cause, their distributions, control, and molecular systematics. Following these sections, there are dichotomous and synoptic keys to the genera – and then the heart of the work, formal taxonomic treatments with full nomenclatural information, detailed descriptions (including ones of cultures), data on hosts and distribution, details of specimens examined, excellent line drawings and photomicrographs, and often extensive “Notes”. Twenty-two species are accepted, and these are now referred to eleven different genera. A further four species are excluded as belonging elsewhere, and several others of “questionable” status (not “validity” as used in the section headings, as all the names seem to be validly published) are discussed.

Such studies may at first be assumed to be remote and somewhat irrelevant by many hands-on plant pathologists, but in reality they are the essential underpinning of *all* critical work in plant and forest pathology. I was very pleased to see APS Press demonstrate, by publishing this work, that they recognize the value of authoritative and critical taxonomic revisions of fungal groups including plant pathogens. It is to be hoped that APS will be encouraged

to publish more basic systematic works in mycology as a result of the reception this title undoubtedly will receive.

The genera of the *Parmulariaceae*. By Carlos Antonio Inácio & Paul F. Cannon. 2008. CBS Fungal Diversity Centre, P. O. Box 85167 AD Utrecht, The Netherlands <info@cbs.knaw.nl>. Pp. 196, figs 112, tables. [CBS BIODIVERSITY SERIES no. 8.] ISBN 978-90-70351-72-4. Price 40 €.

Monographic revisions of families and genera are the backbone of taxonomy, but too rarely seen today as they cannot usually be accomplished during the 3-5 year period of a PhD or research grant. That this publication represents the results of a PhD is a major achievement in itself. This primarily tropical family of foliicolous *Dothideomycetes* has experienced changing circumscriptions and never been revised in depth; indeed it has been largely neglected for the last three decades. The changing views are reflected here in a synopsis of the different treatments of genera from the late nineteenth century to date. No molecular data are available to confirm the placement of the family or of genera within it, but it is compared here with similar families, especially *Asterinaceae* from which it differs in having immersed to erumpent pulvinate and not strongly flattened ascomata with internal stromata, ascomata with the upper walls rarely of radially arranged cells, and generally lacking superficial mycelium and appressoria. Following a thorough account of the characters used in the taxonomy of the family, including those of the pycnidial anamorphs, host ranges and geographical distribution, is a key to the 34 genera accepted here; a further 24 generic names are treated as synonyms. The generic concepts adopted are traditional, and mainly based on differences in the ascomata and associated stromatic tissues together with ascospore septation and colour. This is necessary in the absence of molecular evidence, and it will be of interest to see how the concepts hold up to future molecular scrutiny.

For each genus, information on its history, typification, and differentiation is followed by full accounts of each species that is accepted, including line drawings and photomicrographs, although some of the latter sadly do not come up to the standard seen in other recent CBS publications. Two new generic names had been introduced by the authors elsewhere, *Mintera* and *Viegasella*; *Parmulariella* is included in the family; *Chaetaspis* and *Kentingia* are regarded as of uncertain position; and *Apoa* is accepted as distinct from *Pachypatella*. Twelve new combinations are made, and around 100 species are accepted in the family.

The monograph concludes with a checklist covering accepted names and synonyms, an index to host names by family, and one to binomials; an index by epithet would have been a useful adjunct.

This monograph will open up the possibilities for identifying these fungi to mycologists in the tropics, and hopefully stimulate more of them to become interested in foliicolous ascomycetes.

Neotropical *Hypocrella* (anamorph *Aschersonia*), *Moelleriella*, and *Samuelsia*.
By Priscila Chaverri, Miao Liu & Kathie T. Hodge. 2008. CBS Fungal Diversity Centre, P. O. Box 85167 AD Utrecht, The Netherlands <info@cbs.knaw.nl>. Pp. 68, figs 22, tables 3. [STUDIES IN MYCOLOGY no. 60.] ISBN 978-90-70351-74-8. Price 40 €.

This number of the STUDIES includes a single paper, the full title of which is not that on the cover but the more expansive: "A monograph of the entomopathogenic genera *Hypocrella*, *Moelleriella*, and *Samuelsia* gen. nov. (Ascomycota, Hypocreales, Clavicipitaceae) and their aschersonia-like anamorphs in the neotropics". I guess the longer version is the one those referencing this work should cite, but this will surely occasion some confusion! This is essentially a multi-gene molecular phylogenetic and morphological study, which leads to the recognition of three genera that can all be separated on the basis of the disarticulation of the ascospores and the shape and size of the conidia. *Moelleriella* (22 species, six new, and 17 new combinations) has multiseptate ascospores that disarticulate at the septa while still inside the ascus and aschersonia-like anamorphs with fusoid conidia; *Hypocrella* s. str. (five species, two new) has filiform to long-fusiform ascospores that do not disarticulate and *Aschersonia* s. str. anamorphs with fusoid conidia; and *Samuelsia* (five species, all new) filiform to long-fusiform ascospores that do not disarticulate and aschersonia-like anamorphs but with small allantoid conidia. In addition, there are notes on five doubtful or excluded species. The species-level separations are also supported by morphological data, with stroma colour, ascospore, and conidium featuring most strongly in the keys. I was pleased to note that no independent names had been introduced for anamorphs. There is a suite of keys, both synoptic and dichotomous for each genus, with independent ones for the anamorphs. All species are described in detail and beautifully illustrated, with the habit and cultures shown in colour. Some of the colours are due to cytotoxic anthraquinones, rugulosin, and skyrin. However, it is the toxic destruxins formed that may be most important in insect pathogenicity. The study as a whole is an excellent example of how traditional and molecular data sets can come together to produce a most satisfying new taxonomy. This will surely help place work on the use of these fungi as biocontrol agents on a sounder footing than ever before. The authors now need to consider utilizing the new generic concepts in the production of a world monograph

Black fungal extremes. Edited by G. S. de Hoog & M. Grube. 2008. CBS Fungal Diversity Centre, P. O. Box 85167 AD Utrecht, The Netherlands <info@cbs.knaw.nl>. Pp. vi + 194, figs numerous, tables. [STUDIES IN MYCOLOGY no. 61.] ISBN 978-90-70351-73-1. Price 60 €.

This issue of *STUDIES* is based mainly on a “Black Yeast” international workshop held just outside Utrecht on 26-28 April 2007, and which I was privileged to attend. It was a very special occasion in bringing together mycologists working on these fungi in quite different situations and whose paths rarely cross let alone stop and talk. The topics covered human infections, diseases of cold-blooded animals, fungi growing on rock and in lichens, application in bioremediation, occurrence in drinking water, susceptibility testing, and of course molecular systematics and evolution. Eighteen papers are included here, and it would take too much space to mention them all individually now. However, the ones likely to be of most interest to readers of *MYCOTAXON* are concerned with: two new dothidealean genera described from rocks and lichens in the Antarctic, *Elasticomyces* and *Recurvomyces* (pp. 1-20); a reappraisal of *Aureobasidium pullulans* and its varieties (pp. 21-38); phylogenetic studies of black fungi isolated from 13 lichen species, which yielded *Cladophialophora*, *Mycosphaerella*, and *Rhinocladiella* species (pp. 83-90); the demonstration by molecular phylogenetics that the common ancestor of the mainly lichenized *Verrucariales* and the largely pathogenic *Chaetothyriales* was probably rock-inhabiting and non-lichenized (pp. 111-119); and a molecular analysis of 48 *Cladophialophora* strains leading to the description of four new species (pp. 175-191). This really shows the synergy to be gained from mycologists working on similar fungi but from different habitats collaborating, and this *Studies* thus merits attention from groups traditionally as remote as medical mycologists and lichenologists. Another fine example of the “thinking out of the box” Sybren de Hoog always does so well, and of course edited and produced to the highest standards that are now the norm for the series.

Leaf-inhabiting genera of the *Gnomoniaceae*, *Diaporthales*. By M. V. Sogonov, L. A. Castlebury, A. Y. Rossman, L. C. Mejia & J. F. White. 2008. CBS Fungal Diversity Centre, P. O. Box 85167 AD Utrecht, The Netherlands <info@cbs.knaw.nl>. Pp. 79, figs 48. [STUDIES IN MYCOLOGY no. 62.] ISBN 978-90-70351-74-8. Price 40 €.

The overall systematics of this family of mainly leaf-inhabiting ascomycetes, with generally long-beaked discrete perithecia and hyaline ellipsoid to fusiform colourless and mainly 0-1 septate ascospores, has hardly been revisited since the classic monograph of Monod (1983), which accepted 22 genera and catalogued all species known in each genus. This new revision is focused around *Gnomonia* itself, and based on not only morphological but also molecular evidence derived from multiple gene analysis of 64 isolates, and ITS-only sequences from a further

322. Six genera are accepted here: *Ambarigonimia* gen. nov. (for *G. petiolarum* on *Liquidambar*, the perithecia of which have a white collar at the base of the neck), *Apiognomia* (with one new combination), *Gnomonia* (including eight new species and two new combinations), *Gnomoniopsis* (with six new combinations), *Ophiognomia* (three new species and two new combinations), and *Plagiostoma* (one new species and four new combinations). A table (p. 10) summarizes the distinguishing characters and differences; the erumpent and collapsing perithecia of *Gnomonia* set it apart, but some of the features given as separating the other genera, particularly variations in ascospore shape and septation and appendages, did not appear so clear-cut to me. There is a key to 59 species in all, of which 22 are described and illustrated in detail. The photographs are superb, especially those showing single whole perithecia both on leaves and in culture, some “extracted and rehydrated”. There are various type and epitype designations, and a synopsis of 20 genera not dealt with in the body of the work as excluded from the family, not studied, or dealt with in separate publications (e.g. *Cryptosporella*). A fine example of a systematic revision utilizing molecular, morphological, and cultural approaches.

Monod M (1983) Monographie taxonomique des *Gnomoniaceae*. BEIHEFTE ZUR SYDOWIA 9: 1-315.

European species of *Hypocrea*. Part I. The green-spored species. By Walter M. Jaklitsch. 2009. CBS Fungal Diversity Centre, P. O. Box 85167 AD Utrecht, The Netherlands <info@cbs.knaw.nl>. Pp. 93, figs 37. [STUDIES IN MYCOLOGY no. 63.] ISBN 978-90-70351-76-2. Price 40 €.

Having just prepared a note drawing attention to the increase in known *Trichoderma* species from nine to over 100 over the last 40 years, and then of large numbers of further novel species now being discovered in the neotropics (Hawksworth 2009), it was something of a shock when this STUDIES arrived. The species richness of the genus is evidently not just a tropical phenomenon, as Jaklitsch informs us that no less than 75 *Hypocrea* species have now been identified in Europe. Just the species with green ascospores are revised here, based on cultures obtained from ascospores, morphological, and multigene molecular phylogenetic analyses. Material was collected in 14 countries, with the emphasis on central Europe. Nineteen species forming green ascospores are recognized in *Hypocrea* here, of which six are described as new to science. Most are additions to already known clades, but three — *H. spinulosa* and two new species — represent a new clade altogether. The information presented on both the sexual and asexual states of the individual species is impressively detailed, as is the investigation of the nomenclature and typifications. The species are illustrated in colour, and I was very pleased to see that these often had a range of stromata from different collections of the same species, as well as photographs

of cultures on several media. In what may at first seem contrary to Rec. 59A.3 of the CODE, five new formal binomials in *Trichoderma* are introduced for the anamorphs where new *Hypocrea* species are being described or where they did not exist. I say “at first” because the author indicates that the additional names in *Trichoderma* are established “in order to provide combinations in *Trichoderma* for a possible scenario in the future that may demand the use of *Trichoderma* for the holomorph” (p. 4). He is evidently against the one-name-one-species move, considering that it would disrupt existing concepts, cause chaos, and contribute to the disrepute of taxonomists — opinions I and many other mycologists do not share. Wisely, for the newly described species, he commendably uses the same epithets for both states. However, if the prospective changes in the rules enable *Trichoderma* to be used for the whole fungus, the epithets in *Trichoderma* names could well still need to be epitypified by material with ascospores – but this issue is still far from settled. These nomenclatural quibbles should in no way detract from the excellent scientific quality of this study, which, with the eventual Part II, will provide a sound basis for the identification of these fungi in Europe. Yet I doubt that this will be the last word on the matter. The new collections were mainly from central Europe, and especially Austria as “most European climatic zones are represented in this country” (p. 14), but that area does not contain examples of either Atlantic oceanic habitats or the most severe Mediterranean climates. I suspect there are even more new species to be found in Europe as there seem to be geographical or climatic differences. The author notes, for example, that one rare species not in the green-spored group, *H. tremelloides*, was collected five times within eight days in various parts of England

Hawksworth DL (2009) A plethora of undescribed neotropical *Trichoderma* species. MYCOLOGICAL RESEARCH 113: 1337.

Biodiversity of the powdery mildew fungi (*Erysiphales*, *Ascomycota*) of Israel.

By Svitlana O. Voytyuk, Vasyl P. Heluta, Solomon P, Wasser & Eviatar Nevo. 2008. A. R. G. Ganter Verlag, FL-9491 Ruggell [Distributed by Koeltz Scientific Books, Herrnwaldstrasse 6, D-61462 Königstein, Germany <koeltz@t-online.de>]. Pp. ix + 290, figs 120, tables 5. [BIODIVERSITY OF CYANOBACTERIA, ALGAE AND FUNGI OF ISRAEL no. 7.] ISBN 978-3-906166-74-2. Price 89 €.

This study is based on material collected since 2002, specimens in collections, and literature reports. The book is divided into five chapters. The first four address: the main features of Israel; materials and methods; life-cycles, morphology and the taxonomic system (with fine SEMs of conidium surfaces); and the status of the order in Israel. This last chapter, in addition to analyzing by hosts and geographical elements, includes a “mycoflorogenetical analysis” somewhat speculatively discussing migration routes into the country. More surprising to me was to find embedded in such a book a 13-page phylogenetic

study of 18 *Leveillula* species based on ITS and tubulin gene sequences; the results were compared with SEM features of the conidia, in some cases substantiating differences. That study surely merited wider exposure through publication in an established journal than it will ever receive from being within these covers. These chapters fill 86 pages, and the remainder of the volume is devoted to the powdery mildews recorded from Israel, in total 64 species dispersed through eight genera. There are keys to genera and species, and for each species details of places of publication of accepted names and synonyms, full descriptions, information on hosts and distribution (mostly with maps) and photomicrographs, sometimes accompanied by line drawings or SEM micrographs. I found the detail of the information given on all records somewhat daunting as for some species it occupies several pages and wondered it that might have been better just summarized or at least placed in small type. The volume concludes with separate host and fungus indexes. It is pleasing to see this somewhat eclectic series continuing, as it is of regional and not only national relevance as there are so few works for the identification of fungal groups in the neighbouring countries.

Atlas of the geographical distribution of fungi in Poland. Fasc. 4. *Laboulbeniales*. By Tomasz Majewski. 2008. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland <ed-office@ib-pan.krakow.pl>. Pp. 240, maps. ISBN 978-83-89648-55-6. Price 45 €.

The last fascicle in this series appeared in 2005 (see MYCOTAXON 96: 335, 2006) and was devoted to something of a *potpourri* of macromycetes. This one is different, in that it is devoted to a single order, and prepared by one of the world's foremost specialists on *Laboulbeniomycetes*. It is also different in that it has introductory sections on the overall systematics of the order, and the collection (something I have personally found extremely difficult!) and preservation of these fungi. The treatment of the species has also been changed, and data are included on places of publication, sources of descriptions and illustrations, hosts, and distribution and ecology in Poland. Locality and collection details are given as before, but the maps have been reduced to about one third the height of a single column rather than being full-page. Somewhat unusually, but reflecting our poor state of knowledge of these fascinating fungi, is a list of eight as-yet undescribed species and their localities. In total, 206 species are treated. Notes on three erroneously reported species are also provided, and there are separate indexes to the scientific names of the "animals" and the fungi. This work is much more than an ATLAS! It is intended as a "comprehensive review" (p. 5) of the order in Poland based on over 10 000 collections made by the author and his numerous publications, which include a 1994 monograph. It is published now "as this cycle of activity is coming to an end" (p. 5), which

I trust may not prove to be entirely true as Tomasz is only 69 years old, and his beautiful drawings and meticulous taxonomic treatments would be sorely missed by all concerned with these weird and fascinating fungi.

Aspergillus: molecular biology and genomics. Edited by Masayuki Machida & Katsuya Gomi. 2010. Caister Academic Press, Rowan House, 28 Queens Road, Hethersett, Norwich NR9 3DB, UK (www.caister.com). Pp. x + 238, numerous figs. ISBN 978-1-904455-53-0. Price £ 159, US \$ 310.

This book, to be released on 1 January 2010, provides a wide overview of the forefront of *Aspergillus* genomics from bioinformatics and systems biology to gene regulation, secondary metabolism, and novel industrial applications. It comprises ten chapters involving 29 authors from eight countries, with Japan and the USA predominant. The focus is very much basic genomics and no chapter is focussed on medical aspects such as aspergillosis. This work is mentioned here, as while not primarily systematic, two chapters will be of particular interest to fungal systematists. First, Joan W. Bennett's pragmatic and perceptive overview of the history and nomenclature of the genus, in which she is critical of jargon and points out that "sometimes nomenclatural decisions go against common sense" (p. 6). Second, Robert W. Samson and János Varga's synopsis of the present state of systematics in the genus, with summaries of the currently accepted eight subgenera and various sections – and the 13 teleomorph "genera" linked to the different subgenera and sections. These two chapters merit careful reading and reflection by those mycologists currently debating how the current rules for the nomenclature of pleomorphic fungi should best be modified to achieve the goal of one-name-one-fungus. Sadly, the high price may preclude these and other contributions securing the wider readership they merit.

Alternaria: an identification manual. By Emory G. Simmons. 2007. CBS Fungal Diversity Centre, P.O. Box 85167 AD Utrecht, The Netherlands <info@cbs.knaw.nl>. Pp. iv + 775, figs 288. [CBS FUNGAL DIVERSITY SERIES No. 6.] ISBN 978-90-70351-68-7. Price 170 €.

The ubiquitous pleosporaceous anamorph genus *Alternaria* (teleomorph *Lewia*) includes several notorious host-specific plant pathogens and numerous saprotrophs. Members of the genus are frequently isolated from soil and plant debris, or as spoilage agents from food. They are also often reported as endophytes of plants, as (opportunistic) pathogens of mammals, and among the highly allergenic mycobiota in damp indoor spaces. Numerous secondary metabolites with pronounced bioactivities are known from *Alternaria* species, including host-specific phytotoxins, as well as hazardous mycotoxins and selective antibiotics.

Despite the ubiquitous occurrence of *Alternaria* species and their undisputable practical importance, no concise and complete monograph on the genus had been published to date. Non-taxonomists often relied on rather broad species concepts in which saprotrophic and plant pathogenic fungi were treated under the same aggregate names and founded on gross morphological similarities. Evidently, such a classification does not adequately reflect the biology of these fungi. Alternatively, concise species concepts are needed to satisfy the needs of plant pathologists, building mycologists, bioprospectors, ecologists, and biodiversity researchers who work with unambiguous data.

Fortunately, a valuable alternative has now become available, due to the efforts of Emory G. Simmons, who has been focusing on *Alternaria* and allies for more than five decades. His series “*Alternaria* themes and variations”, comprising over 300 articles in MYCOTAXON, should certainly be well known to the readership of the journal. His meticulous studies and his pragmatic morphological species concepts have already helped to resolve some complicated species complexes, to recognize certain anamorph-teleomorph relationships, and to segregate some aberrant forms from the mainstream of the genus *Alternaria*, now transferred to different genera. Various plant-associated taxa formerly regarded as “special forms” or “host-specific varieties” can meanwhile be recognized as good species.

The MANUAL not only summarizes the state of the art of the above-mentioned studies but attempts to provide a means of sound morphological identification of all currently accepted *Alternaria* taxa for the first time. Nevertheless, it is not intended to be a monograph. As the author states, his effort to provide a complete monographic work was “interrupted” by the work on the current MANUAL. However, the wealth of information contained in this monumental work makes me wonder whether this is not just a mere understatement.

The bulk of the MANUAL is dedicated to meticulous descriptions and line drawings of 276 accepted, well-circumscribed species (at least two pages deal with each of these taxa). In the illustrated part, special emphasis is given to micromorphological characters of the cultures grown under standard conditions and to the characteristics of the available type specimens. Twenty additional species that need further study are treated less extensively.

These detailed morphological treatments are preceded by a relatively short but complete summary of the taxonomic and nomenclatural history of *Alternaria*, comments on previous and alternative species concepts, and descriptions of methods for cultivation and morphological studies. For other aspects that do not deal with identification and morphology, the reader is referred to a rather comprehensive list of references. The segregation of *Alternaria* from morphologically somewhat similar genera (e.g. *Embellisia* and *Ulocladium*) is also addressed before the above-mentioned species are keyed

out. Eleven species groups in *Alternaria* are distinguished, based mainly on sporulation patterns and conidial morphology. Concise illustrations and useful general comments in the preambles greatly facilitate usage of the keys.

The MANUAL includes no fewer than 70 new species descriptions and 18 new combinations. In addition, three new generic names (*Alternariaster*, *Chalastospora*, and *Teretispora*) are introduced for species formerly placed in *Alternaria* that show significant deviations from the mainstream of species still included.

Those who are interested in taxonomic history and nomenclature will find a comprehensive list of over 1100 names associated with *Alternaria* through the past 200 years, including comments on their current status and references to their typification. These data are particularly valuable because they come from the only person who has actually seen all the relevant extant material. Notably, many of these names are based on herbarium specimens, while the presented species concepts rather rely on characteristics observable in culture. Hence, only the latter species are keyed out and illustrated in detail to avoid inconsistencies.

Based on some *Alternaria* strains from our culture collection, I have tested these keys with my students. We found it easy to recognize the proposed sporulation patterns, while species identification still appeared rather difficult, probably due to our lack of experience. Sometimes the dichotomous keys presented are apparently not sufficient, confirming a pertinent remark in the introductory section that multiple characters need to be observed in concert, in order to allow for a precise identification. It occurred to me that synoptic keys might be adequate, e.g. for differentiation of all the small-spored taxa, which are very tricky to discriminate. Such synoptic identification systems, however, could probably be realized more easily on a computer-based platform than in a printed medium.

In conclusion, the MANUAL serves its purpose very well; albeit some familiarity with the genus is helpful. When in doubt it might be advisable to study authoritatively named reference cultures for comparison.

Without doubt, this book will be of great utility both in basic and applied mycology. In my opinion it proves convincingly that careful morphological studies will always remain indispensable, no matter which alternative methodology will be employed or developed in the future. At present, the utility of molecular phylogenetic methods for segregation of *Alternaria* appears to be limited. At least the discriminatory potential of (ITS) nrDNA sequence data does not apparently reflect the morphological and biological diversity in *Alternaria* as described in the MANUAL, as judged from the data available as now. However, other mycologists have faced similar problems during their work on other groups of filamentous ascomycetes. Realizing that rDNA sequence

data have limited utility, they finally succeeded in their phylogeny becoming congruent with morphological hypotheses by using different genes or even multi-gene genealogies, or by taking non-morphological phenotype-based evidence into account. The present status of *Alternaria* morphotaxonomy really cries for additional, polyphasic studies.

This MANUAL will also open new avenues for verification of the morphological concepts by means of complementary methodology, involving non-morphological studies of the phenotypes and genotypes. Numerous representative strains that have been meticulously studied by the author are already available in public genetic resource collections. This provides an ideal prerequisite for follow-up work using complementary techniques. Indeed, such studies have already been undertaken in the past years, demonstrating that certain practically important features, including secondary metabolite production, are largely in agreement with the morphological concepts proposed in the MANUAL.

I could only imagine that chemotaxonomic and molecular phylogenetic studies on *Alternaria* will eventually not only reinforce but perhaps even refine these concepts. The MANUAL, in any case, constitutes a masterpiece of what might be termed “morpholomics”. I can only highly recommend it to all mycologists who are involved in the study or identification of conidial fungi. I sincerely hope the author will continue to actively pursue his monographic work for many years, and that many younger mycologists will be keen to follow his example.

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LICHEN-FORMING AND LICHENICOLOUS FUNGI

Pyrenocarpous lichens with bitunicate asci: A first assessment of the lichen biodiversity inventory in Costa Rica. By André Aptroot, Robert Lücking, Harrie J. M. Sipman, Loengrin Umaña & José Luis Chaves. 2008. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany <mail@schweizerbart.de>. Pp. 162, figs 32, tables 3. [BIBLIOTHECA LICHENOLOGICA no. 97.] ISBN 978-3-443-58076-6. Price 68 €.

Crustose lichens occurring on bark in the tropics, other than graphids and thelotremes, are one of the outstanding major challenges for lichenologists today. Huge numbers of taxa have been described, especially in the mid-nineteenth and early twentieth centuries, and often in large genera with many hundreds of names that have not been critically assessed according to current generic, let alone species, concepts. This brave attempt to tackle this problem for Costa Rica accepts 181 species distributed through 32 genera. One new family

(*Celotheliaceae*) and 15 new species are described, and 13 new combinations made. Particularly valuable have been revisions of type material that have led to the synonymization of 20 names, mostly coined by Müller Argoviensis or Dodge, with previously described species. Keys are provided to genera and species, arranged with a set of six sub-keys pragmatically based on ascospore colour and septation. The species entries are presented in a single alphabetical sequence, without places of publication of the names themselves, but with brief descriptions, information on their distribution, a list of specimens examined, and in some cases notes or half-tone habit photographs or photomicrographs of the spores. The inventory is surely far from complete, but it is based on an impressive 1735 collections made from 34 sites, mainly in 2002-2004, as well as historic collections. Unusual for a primarily systematic study is a multivariate analysis of the sites, which distinguished six categories from lowland deciduous dry forest to the upper montane rain forest. This analysis also highlighted some indicator species of the different forest types. While not all lichenologists might concur with some parts of the classification and generic concepts adopted, there can be no doubt that this work will serve as THE starting point for the identification of pyrenocarpous lichens in the neotropics.

Hongos liquenícolas del Sur de Sudamérica, especialmente de Isla Navarino (Chile). By Javier Etayo & Leopoldo García Sancho. 2008. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany <mail@schweizerbart.de>. Pp. 302, figs 132, incl. 2 maps. [BIBLIOTHECA LICHENOLOGICA no. 98.] ISBN 978-3-443-58077-3. Price 74 €.

South America is still relatively unexplored for lichens and lichenicolous fungi. It has become in recent years more and more attractive to lichenologists desiring to discover new species, explore the biodiversity of species in still well preserved areas of our natural heritage, or study climate change using lichens to elucidate what is happening in the Southern Hemisphere. This is especially true for European lichenologists who are saturated with well-explored European areas. Lichenicolous fungi are highly under-collected in this continent. The potential richness of lichenicolous fungi in South America is very high, and many new species and genera could be expected to be described in future. The current number of described lichenicolous fungi in the world is about 1700 species, but based on the rapidly increasing number described over recent decades, we can easily expect 3000 species to be reached in the near future. Therefore, it is not surprising that the lichenicolous fungi of this largely unexplored continent attracted Spanish lichenologist Javier Etayo. With every one of Etayo's publications on lichenicolous fungi from South America, he substantially increases the number of known species in the world. In his monograph on lichenicolous fungi of Colombia (BIBLIOTHECA LICHENOLOGICA 84: 1-154,

2002; see MYCOTAXON 87: 500-501, 2003), he described 52 species of the 104 species identified (every second one was new for science!) and even noted that 47 further taxa could not be described because of insufficient material or being in poor condition. It is not surprising that the current monograph published with co-author Leopoldo García Sancho on lichenicolous fungi mainly from Chile increases the number of new taxa known from South America even further. All specialists studying lichenicolous fungi will want to have this new book with such a comprehensive amount of information in his or her bookcase as much as they wanted to have his former book.

An international group of lichenologists from Spain and Denmark undertook two expeditions (in 2005 and 2008) to southern Chile and Argentina. They explored 60 localities, most of them in the Isla Navarino in the Beagle Channel. The present study of lichenicolous fungi is based on 696 samples representing 240 species, of which 189 are published in this book and of which six genera and 60 species are described as new to science. Still, a further 51 species remain as undescribed!

In 1999, Galloway & Quilhot (GAYANA BOTANICA 55: 111-185, 1999 ["1998"]) published a checklist of Chilean lichen-forming and lichenicolous fungi in which they reported only 32 lichenicolous fungi, based mainly on the collections of Spegazzini, Dodge, and Wedin.

The new species are described in detail and are well documented by 123 (of 132) excellent drawings and photographs, which we have come to expect as typical for Etayo. The introductory chapters are well written, and introduce the abiotic factors that influence the area as well as biotic factors (mainly vegetation types). Separate chapters discuss the hosts, co-evolution, and host specificity of lichenicolous fungi. A short note promises that a full account of the lichen biota of the study area will be published too.

Six new genera are described: *Atronectria*, similar to *Pronectria* but with brown, K+ blackish green ascomata; *Macrographa*, with large ascomata and three septate spores of unknown affinities; *Pseudostigmidium*, related to *Stigmidium*, but generally with an I+ red hymenium and 3-septate spores, with five species living on *Pseudocyphellaria* and *Nephroma*; *Sarcoexcipula*, with a thick and complex perithecial wall and large and septate ascospores; *Umbilithecium*, an *Arthonia*-like genus but with a different hymenial structure and simple spores; and *Umushamyces*, similar in habit to *Arthonia*, but with *Biatora*- or *Bacidia*-type asci.

Sixty new species are described in *Arthonia*, *Atronectria*, *Bachmanniomyces*, *Capronia*, *Carbonea*, *Chalara*, *Corticifraga*, *Corticiruptor*, *Dactylospora*, *Diederimyces*, *Endococcus*, *Leptosphaeria*, *Lichenochora*, *Lichenopeltella*, *Macrographa*, *Merismatium*, *Microsphaeropsis*, *Minutoexcipula*, *Muellerella*, *Nanostictis*, *Nectriopsis*, *Neobarya*, *Niesslia*, *Odontotrema*, *Phaeosporobolus*,

Phoma, *Plectocarpon*, *Polycoccum*, *Pronectria*, *Protothelenella*, *Pseudostigmidium*, *Rhagadostoma*, *Sarcoexcipula*, *Sclerococcum*, *Scoliciosporum*, *Skyttea*, *Sphaerellothecium*, *Stigmidium*, *Taeniolella*, *Toninia*, *Trichonectria*, *Umbilithecium*, *Umushamyces*, *Unguiculariopsis*, and *Xenonectriella*. In addition seven new combinations are made and two new synonymies proposed, including placing the generic name *Kalaallia* as a new synonym of *Opegrapha*.

A key to species is provided for several genera covering species occurring in the study area: *Capronia*, *Corticifraga*, *Dactylospora*, *Endococcus*, *Nanostictis*, *Neobarya*, *Niesslia*, *Phaeosporobolus*, *Phoma*, *Pronectria*, and *Pseudostigmidium*. Unfortunately, overall keys to genera treated and the large genus *Arthonia* are not provided. An alphabetical list of lichen hosts and their fungi concludes the work, together with extensive literature citations, which will be much appreciated. *Pseudocyphellaria* and *Nephroma antarcticum* emerge as hosts that support really surprising numbers of lichenicolous fungi!

Etayo's work deserves the highest evaluation. Lichenologists working in the Southern Hemisphere in particular will find this book very important for their own future studies of lichenicolous fungi. I am sure this work will encourage the interest of many new lichenologists and students in the discovery of as yet hidden additional lichenicolous fungi.

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Biodiversity and ecology of lichens: Liber amicorum Harrie Sipman. Edited by André Aptroot, Mark R. D. Seaward & Laurens B. Sparrius. 2009. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany <mail@schweizerbart.de>. Pp. 439, figs 117, tables 12. [BIBLIOTHECA LICHENOLOGICA no. 99.] ISBN 978-3-443-58078-0. Price 89 €.

This volume is designed to pay tribute to Harrie Sipman, ever the Dutchman, who has spent his entire postgraduate career as lichenologist at the Botanical Garden and Museum in Berlin, as he enters his final year to retirement. The collection comprises 26 papers, plus an account of his professional life and lists of his publications and new taxa he introduced. They have been prepared by his colleagues, and nine contributions are by or co-authored with André Aptroot. The main focus of Harrie's work has been the tropics, and photographs of him in the field in Brazil, Guyana, and New Guinea are included. The volume consequently has a strong tropical focus, in which the papers on the Biogradska Gora National Park in Montenegro and two new *Cladonia* species from Iceland, for example, seem rather out of place. New taxa are described from Australia (in *Caloplaca* and *Xanthoparmelia*), Brazil (in *Chapsa*), the Canary Islands (in *Bacidia*), Korea (six pyrenocarpous species), Namibia (in *Buellia*), Thailand (in

Cryptothecia and *Stirtonia*), and the West Indies (in *Micarea*). There is also a checklist of lichens from the Seychelles group, and a catalogue of the liverworts and hornworts (yes, not the lichens) of the Galapagos Island (by Robbert Gradstein, one of Harrie's early mentors). However, of the widest interest here are the revisionary papers, the longest of which, at 48 pages, is on the re-instatement of *Herpothallon* as distinct from *Cryptothecia*, with 29 species now accepted in *Herpothallon*, of which 17 are newly described and 13 combined into it; but I do wonder whether conservation of *Cryptothecia* with a different type might have been a preferred option in the interest of nomenclatural stability, as some of these lichens are so conspicuous and well-known. There is also a synopsis *Placopyrenium*, which accepts 14 species (three newly described), a key to the known species of the lichenicolous genus *Sphaerellothecium* (19 species, one newly described), the resurrection of *Trypetheliopsis* (six species, five newly combined), which proves to be an earlier name for *Musaespora* described in 1993, a new genus of *Arthoniaceae* (*Synarthothelium*) for two new species from Costa Rica and Venezuela), molecular phylogenetic studies to determine the positions of *Schistophoron* and *Tylophoron*, and a new worldwide key to cryptothalline species of *Lecidea* (ones forming endolithic thalli and accompanied by fine coloured photomicrographs of apothecial sections). Of especial interest to those fascinated by the evolutionary history of lichens is a critical examination of the evolution of cyanobacterial symbioses based on molecular sequence data; it is concluded that these mutualisms evolved repeatedly, and that now seems clear for *Lecanoromycetes*, but with *Lichinomycetes* still basal to the *Lecanoromycetes* (albeit with ambiguous support), this may not be the last word on this topic!

This is a Festschrift that all working with tropical crustose lichens in particular will wish to have on their shelves. I am sure Harrie will enjoy it and reflect how far knowledge on these lichens has progressed since his monograph of the mainly tropical *Megalosporaceae* was published as no. 18 in BIBLIOTHECA LICHENOLOGICA back in 1983. I am sure all lichenologists will wish him a fulfilling and productive "retirement."

Diversity of lichenology – anniversary volume. Edited by Arne Thell, Mark R. D. Seaward & Tassilo Feurer. 2009. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany <mail@schweizerbart.de>. Pp. 512, figs (some colour), tables. [BIBLIOTHECA LICHENOLOGICA no. 100.] ISBN 978-3-443-58079-7. Price 124 €.

This volume is published to celebrate a major achievement in the history of lichenological publication – BIBLIOTHECA LICHENOLOGICA reaching its 100th volume, 36 years after the series was initiated by Jörg Cramer in 1973 with Josef Poelt as its' advisor. It soon became, and has continued to be, THE place for the publication of monographs, symposia, and Festschriften on

lichens and lichenicolous fungi, and has been under the overall editorship of Volkmar Wirth since 1983. This volume starts with a history of the series and list of the works so far included and then continues with 17 further chapters; these are contributed by 37 authors from 13 countries and are all in English, reflecting the international status the series has evolved into from its Austro-German dominated early years. Hidden amongst these is an 85-page article on “Fifty influential lichenologists” compiled by Ingvar Kärnefelt, which has brief biographies with photographs of the 50 persons selected. Ingvar makes clear this is “very much the author’s personal choice.” The selection must have been difficult, and while I was personally gratified and humbled to find myself included, I was surprised not to find, amongst others, Ken Kershaw, William Lauder Lindsay (1829-1880), David Richardson, David Smith, Vittore Trevisan (1818-1897), or Wilhelm Zopf (1846-1909) – all of whom have done so much in laying the foundations of aspects of modern lichenology. I shall not suggest which persons might have been dropped in their stead . . .

It is not clear to me how the topics and authors of the other contributions were selected, but they certainly live up to the title of the volume in the range of subjects involved. Most have a systematic bent, and all cannot be mentioned here. However, the most far-reaching of these has to be the molecular phylogenetic study of xanthorioid lichens by Natalya Fedorenko and colleagues in which three further new genera are recognized to add to the three others also introduced in recent years: *Jackelixia*, *Ovealmbornia*, and *Xanthokarrooa*. There is also a major study (73 pp.) of the *Teloschistaceae* in the Southern Hemisphere by Sergij Kondratyuk and others that includes the description of 35 new species, mainly in *Caloplaca*, with many illustrated in colour. Also sure to be widely used are the keys (both dichotomous and synoptic) to the 32 European species of *Usnea* by Tiina Randlane and her group in Tartu, which has the best macro-photographs (many in colour) of diagnostic details in the genus I have seen in print and further distribution maps and discussions of individual species. Topics of other systematic papers include ones on *Phacothecium* (resurrected for *Opegrapha physciaria*), *Polysporina*, *Thelocarpaceae* and *Vezdaeaceae* (to be excluded from *Lecanoromycetes*), and *Traponora* (with four new species added).

The issue of how many tropical lichens there might be on Earth is tackled by Robert Lücking and colleagues in the light of intensive studies in Costa Rica. Based on species-area relationships and ecosystem diversity, they come up with 7,000 for the neotropics, 14,000 for the entire tropics, and 28,000 worldwide – a much higher world figure than previous global estimates. There are also contributions on ecology from the Namibian desert to the Baltic coast, growth-rates of 22 epilithic species in Iceland, the formation of lichen substances by cultured mycobionts, etc. It would have been great also to have more

ecophysiology and biont-interaction biology included as these are increasingly fascinating areas of modern lichenology, but I can appreciate that the authors' could have had problems in securing such papers for this publication.

In reflecting on the success and special place this series has assumed in lichenology, surely the time has come when it should be included in the Thompson Reuters ISI Journal Citation Reports and assigned an Impact Factor. This is especially so as some very comparable works of a similarly sporadic and largely monographic or symposial nature are already included, not least *STUDIES IN MYCOLOGY*, which has the highest IF in the whole of the mycology group of journals at 4.625 in 2008 — even ahead of the prestigious *FUNGAL BIOLOGY AND GENETICS* which has 3.005! In any case, all serious lichenological libraries should maintain a standing order for the series and, if possible, secure any back issues they are missing.

Foliicolous lichenized fungi. By Robert Lücking. 2008. The New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, NY 10458-5126, USA <nybgpress@nybg.org>. Pp. 867, figs 258. [FLORA NEOTROPICA MONOGRAPH no. 103.] ISBN10: 0-89327-491-7; 13: 978-0-89327-491-7. Price US\$ 125.

[Winner of the Société de Physique et d'Histoire Naturelle de Genève (SPHN) 2008 Augustin-Pyramus de Candolle Prize for the best monograph.]

It is a great book: large in size, content, degree, very important, and very good. All meanings of the word “great” apply to it. We waited for it for a long time and also expected a lot from all the sentences what were written in it. Our expectations were mostly due to the subject having been studied by a few lichenologists only — one last summarised by Santesson (1952) in his worldwide monograph – and also due to Robert Lücking's record as the world's most outstanding researcher of the foliicolous lichens today. He is also an outstanding representative of systematists of lichenized fungi, especially for studying crustose taxa in the tropics. His deep interest in these fields is reflected in his approaching the subject in this monograph from various aspects – from history to use, via morphology, anatomy, chemistry, phylogeny, biogeography, ecology, and classification. As a result, we now have a relatively holistic view of the lichens inhabiting this very special substrate: the leaf surface. Almost 900 literature sources were taken into consideration in producing this synthesis.

The term “foliicolous lichens” is reserved for lichenized fungi growing obligately (or more seldom facultatively) on the laminal photosynthetic organs, primarily of angiosperms but some also occur on those of gymnosperms, pteridophytes, and bryophytes. Most colonise the upper surface (epiphyllous taxa), others the lower surface (hypophyllous ones), and some produce fruit bodies at leaf edges. Their distributional area, with a few exceptions, is tropical.

Foliicolous species belong to various higher taxonomic units of lichenized fungi, and systematically are very diverse. Of the more than 800 species so far described, 616 are found in the Neotropics. These are treated here in a systematic order, but an alphabetical index of scientific names of taxa is added. A large proportion of the species known in the world today are included in the artificial keys, and further natural keys to higher taxonomic units are provided. Although not all species known worldwide are included in the keys, material outside the Neotropics is considered when characterising their ecology and distribution. Furthermore, descriptions of orders, families, and genera are based on all members of the group, even including non-foliicolous representatives. The number of infraspecific taxa used and newly described in the monograph is relatively high compared to the usual number in recent treatments. However, one must agree with the author – who regards them as a temporary position for these particular taxa – that more information is required to justify the real taxonomic rank of many. There are an enormous number of taxonomic novelties published in the volume, including new taxa, combinations, and synonymies. There is a numerical list of taxa (pp. 819–829) amongst which are the new family *Lyrommataceae* and four new genera, *Baflavia*, *Brasilicia*, *Eugeniella*, and *Phyllogyalidea*. The first three of these genera originate from the former *Bacidia* s. lat., while *Phyllogyalidea* is separated from *Gyalidea* s. lat. A new section, *Badimia* sect. *Pseudogyalecta*, is also established. No fewer than 60 new species and 13 new infraspecific taxa are also described here for the first time, and 35 new combinations are also made – and not all for taxa which occur in the neotropics. The name *Strigula tremens* is also reintroduced, and ten new taxonomic synonymies established amongst which are three recently described names.

As the new taxa are deposited in several herbaria (including private herbaria) of the world, it would have been convenient to have a list of these (perhaps with information as to their accessibility) in the chapter on Materials.

A review would not be complete without mentioning some details that could have been improved. It was difficult to find any such matters in this case, but perhaps it is worth mentioning that coloured photographs would have been highly appreciated by lichenologists instead of only half-tone black and whites. Foliicolous lichens, as many other lichens, are very colourful, and although half-tones show their great diversity of form, the diversity represented in their colours is missing. This is particularly so as colours can contribute to the successful identification of species. The drawings have been executed with great care, but unfortunately are not all in the same style. In particular, some of the sketches look very different from others (e.g. spore illustrations) – most probably because the lines are thicker on the sketches (e.g. Figs 26 and 29) than on the other figures. A great advantage for comparisons is that the scale for

figures is the same (12.5 mm = 10 µm); however, one is missing from Fig. 86 but can be expected to be the same 12.5 mm for the 100 µm indicated in the legend. The position of letterings indicating spores could also be improved in some places (e.g. Fig. 204). Of course, these are minor things – compared to the extraordinary work achieved in the whole monograph – and could be corrected in another impression or edition.

Lücking's monograph is a monumental work, a huge contribution to our general knowledge on foliicolous lichenized fungi, and also an incredible contribution to our knowledge of world biodiversity. It is indispensable and unavoidable for all who endeavour to carry out research on foliicolous lichens, or to use them as bioindicators in tropical areas generally, and not just in the neotropics. Foliicolous lichens of the palaeotropics are much less known, even if their knowledge is also increasing. Still, most probably we must wait for another generation to achieve a similar compilation of those areas, as well as for a new world monograph to replace Santesson's.

Santesson, R. 1952: Foliicolous lichens I. – *SYMBOLAE BOTANICAE UPSALIENSIS* 12(1): 1–590.

EDIT FARKAS

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The lichens of Great Britain and Ireland. Edited by Clifford W. Smith, Andre Aptroot, Brian J. Coppins, Anthony Fletcher, Oliver L. Gilbert, Peter W. James & Patricia A. Wolseley. 2009. The British Lichen Society, c/o Department of Botany, The Natural History Museum, Cromwell Road, London SW7 5BD, UK. Pp. x + 1046, figs 50, tables 1. ISBN 978-0-9540418-8-5. Price £ 65.

Seventeen years after the first, the second enlarged edition of *THE LICHEN FLORA OF GREAT BRITAIN AND IRELAND* (Purvis et al. 1992) arrived, with a reduced price to British Lichen Society (BLS) members (£ 45). Taking into account that there are only a few modern lichen floras in the world, this will probably become as indispensable as the first edition was, but not only for British or Irish people and students interested in lichens, but for lichenologists more generally. For those who have used the first edition, the second edition volume is over 336 pages longer, with a similar structure and organization of the keys and descriptive parts. However, the Glossary is now located before the generic keys instead of before the references, which takes some practice to become familiar. It deals with 1873 species in 327 genera, adding 72 genera and 386 species to the first edition, and summarizes the effort of several generations of national and foreign lichen taxonomists and amateurs on the Islands. Numbers alone tell the story. New numbers (e. g. new lichen records each semester to the flora; Hitch 2009) add potential for an expectation of the flora's continuation, in spite

of the documented decline of lichen taxonomy and taxonomists generally in the UK (Fletcher 2008). The book, produced with a nice-looking hardcover (renouncing the former characteristic stout red binding), is particularly easy to use even with its larger volume and weight, and friendlier than similar recent lichen floras from different territories in several volumes (e. g. Galloway 2007; see MYCOTAXON 197: 518-520, 2009), but contrary to Galloway's flora, it lacks a free electronic online version. In being rejuvenated, authors of the generic accounts are cited below the genus name at the start of each generic account, and selected literature and illustrations are cited for most. However, it could be more useful to put generic names in the upper right corner of the page rather than the left. Nevertheless, the work definitively maintains the tradition of being as well done and accessible as its predecessor.

Following the multi-authored approach of the first edition, there were contributions from 52 specialists, including 24 overseas lichenologists. After the roman numbered pages including a foreword, acknowledgements, lists of contributors, figures and tables, page one starts with a brief introduction: tips on the use of the monograph, techniques used, and its organization. Next is a systematic arrangement of the accepted genera in the book which closely follows the current "Outline of *Ascomycota* – 2007" (Lumbsch & Huhndorf 2007), but for lichenized *Basidiomycota* the genus *Lichenomphalia* is included in *Agaricales* as *incertae sedis*, instead of in *Hygrophoraceae* as accepted by Kirk et al. (2008). The glossary includes additions and deletions of fungal terminology to the first edition, avoiding technical vocabulary where possible as a concession to non-specialized users, but the reader must be careful as some words are out of alphabetic order, some terms are missing (e. g. cuticle, gills, flesh, used in the account of *Lichenomphalia*, pp. 553-556), and there are overly concise explanations of some words. The generic keys, as the species keys, are dichotomous and well constructed, including easily obtained traditional morphological, chemical and ecological characters. Especially noteworthy is the inclusion of a new artificial key to sterile crustose saxicolous and terricolous lichens (pp. 96-122) that was lacking in the first edition. Surprisingly, there are some contradictions in that key (i.e. Generic key 8) as well in some keys to species and also in the treatments of genera. Using again *Lichenomphalia* as example, in the crustose generic key 8, couplet 17 (p. 98), the sterile bulbiliferous thallus (*Botrydina*-type) of *L. umbellifera* and *L. velutina* are included together because of the absence of other characters that differentiate the species unmistakably, as pointed out by Barrasa & Rico (2001). Contrarily, in the *Lichenomphalia* species key (p. 554), the authors, employ thallus characters such as wall diameter and thickening of the subtending hyphae amongst the bulbils to separate sterile specimens of both species and also *L. alpina*.

In the body of the work, 954 pages treat the genera and species in sequence (except in *Cladonia*). The treatments are mainly based on the first edition, but with additional generic authors added to the byline, newly incorporated genera and species are to be expected. Hard revision has been undertaken, with special care taken with critical taxonomic groups. A new generic segregation in *Parmeliaceae* is adopted following Hawksworth et al. (2008). Thanks to the editors (particularly “Tony” Fletcher and Brian Coppins), most of the genera not treated critically and fully in detail in the first edition are now intensively revised and more comprehensive (e.g. *Aspicilia*, *Caloplaca*, *Lecania*, *Lecanora*, *Lecidea*; but see the interesting and critical review by Fletcher 1994). The main work finishes with two added species in an appendix, 42 pages of references in alphabetic sequence, and an index with the epithets of the mentioned taxa. There are 49 line drawings, five more than in the first edition; these improve the flora and illustrate the glossary and critical characters in the case of difficult species in various genera, but some are poorly scanned or copied.

However, the inevitably commented on small things do not detract from the main achievement of this book, a landmark comprehensive updating compilation for the identification of lichens, not only from Britain and Ireland, but from temperate and oceanic areas in Europe. The book definitely enhances the reputation of the BLS and of the contributors. I use my copy almost every day.

- Barrasa JM & Rico VJ (2001) Lichenized species of *Omphalina* (*Tricholomataceae*) in the Iberian Peninsula. *LICHENOLOGIST* 33: 371-386.
- Fletcher A (1994) Book Reviews: The lichen flora of Great Britain and Ireland. Edited by O.W. Purvis, B.J. Coppins, D.L. Hawksworth, P.W. James & D.M. Moore. London: Natural History Museum Publications with the British Lichen Society. 1992. *LICHENOLOGIST* 26: 217-220.
- Fletcher A (2008) Taxonomist – An endangered species. *BRITISH LICHEN SOCIETY BULLETIN* 103: 2-6.
- Galloway DJ (2007) *FLORA OF NEW ZEALAND: LICHENS, INCLUDING LICHEN-FORMING AND LICHENICOLOUS FUNGI*. 2nd edn. 2 vols. Manaaki Whenua Press, Lincoln, New Zealand.
- Hawksworth DL, Blanco O, Divakar PK & Crespo A (2008) A first checklist of parmelioid and similar lichens in Europe and some adjacent territories, adopting revised generic circumscriptions and with indications of species distributions. *LICHENOLOGIST* 40: 1-21.
- Hitch C[JB] (2009) New, rare and interesting lichens. *BRITISH LICHEN SOCIETY BULLETIN* 104: 42-52.
- Kirk PM, Cannon PF, Minter DW & Stalpers JA (eds) (2008) *AINSWORTH & BISBY'S DICTIONARY OF THE FUNGI*. 10th edn. CAB International, Wallingford.
- Lumbsch HT & Huhndorf SM (eds) (2007) Outline of *Ascomycota* – 2007. *MYCONET* 13: 1 – 58 [<http://www.fieldmuseum.org/myconet/outline.asp>].
- Purvis OW, Coppins BJ, Hawksworth DL, James PW & Moore DM (eds) (1992) *THE LICHEN FLORA OF GREAT BRITAIN AND IRELAND*. Natural History Museum Publications, London.

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The macrolichens of New England. By James W. Hinds & Patricia L. Hinds. 2007. The New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, NY 10458-5126, USA <nybgpress@nybg.org>. Pp. xx + 584, figs 344 (mostly col.), tables 10. [MEMOIRS OF THE NEW YORK BOTANICAL GARDEN no. 96.] ISBN 0-89327-477-1. Price US \$65.

I first encountered this splendid book while teaching a class on lichenicolous fungi at the Eagle Hill Centre in Maine in July 2008, and wished I had known about it before so I could have commended it in advance to my students! It summarises all that is known of the macrolichens of the region based on 35 years of study by the authors – who had attended a course at the centre run by the late Mason Hale in 1988. New England embraces the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. In all, 461 species distributed through 98 genera are treated, of which 28 are reported from New England for the first time and 20 excluded as doubtful. Descriptions are provided for all 461 species and a further 41 known from adjacent states. For each species, synonyms are given, and there are descriptions and notes on range, habitat, and diagnostic features. Each species is given a common name in English, a practice I would personally have preferred not to have seen – after all, who but the authors or users of this book are likely to know that the “Oceanic foam lichen” is *Stereocaulon intermedium*! More importantly, there are superb colour photographs showing the habit of 308 species that are amongst the best I have ever seen.

There is an extensive introduction, including 37 pages of generic keys grouped first by substrate and then habit and colour, and also discussions on the status of species. Helpfully, there is a “Quick key index” on the inside of the front cover, and a map of the counties in the states covered on the inside of the back one. Keys to species within genera appear in the body of the text. With respect to status, sadly, 61 species have not been recorded since 1950, and 257 (55.7 %) are considered regionally rare or declining. The book concludes with lists of excluded species, a glossary, and an index.

As it deals with all, and not just a selection, of the reported species, this volume will surely become the standard reference for the identification of macrolichens in the northeastern USA and adjacent areas of Canada for the foreseeable future. The production is splendid, and the binding tough enough for the extensive use it will surely receive. The love of this husband and wife team for lichens seems to shine through every page. It is a tremendous achievement, and all amateur and professional lichenologists and ecologists working in the region should secure a copy.

Lichen flora of the Greater Sonoran Desert Region. Vol. 3. Edited by Thomas H. Nash III, Corinna Gries & Frank Bungartz. 2007. Lichens Unlimited, Arizona State University, Box 874501, Tempe, AZ 85287-4501, USA. Pp. viii + 567, figs 36, col. plates 56, maps. ISBN 0-9716759-1-0. Price US \$ 49.95, 43 €.

This volume completes this stupendous work, the first volume of which appeared in 2002 (see MYCOTAXON 86: 485-486, 2003) and the second in 2004 (see MYCOTAXON 96: 350-351, 2006). Again it is very much a result of a productive international co-operation and has involved 47 authors from 15 countries. It covers the “balance of the microlichens, and the lichenicolous fungi” – actually 38 lichenized genera and four of lichenicolous fungi. In addition, there is further information on 16 genera covered in the previous volumes where further species have subsequently been discovered. This volume is especially valuable as it includes the treatments of some taxonomically difficult and speciose genera in some of which new species to science have also been discovered: for example, *Acarospora* with eight new species, *Aspicilia* with 19, *Buellia* with two, *Caloplaca*, *Opegrapha* with three, *Usnea* with three, and *Verrucaria* with seven. There are also numerous new combinations and even a new genus, *Romjularia* in *Porpidiaceae* for the species previously widely known as *Psora lurida*. In addition to a few half-tone photographs scattered through the volume, there is a signature of 56 un-numbered pages comprising excellent colour photographs of over 220 species – many more than in the previous volumes. These colour photographs are mainly of species treated in this volume but also include some not figured in colour in the previous two.

The overall layout naturally follows that of the previous volumes, and brings the total number of species covered in the three volumes to 1971, of which 1836 are lichenized – about 40 % of all the species known throughout the whole of North America. This last volume also has some special features: a key to sterile crustose lichens, a revised key to the cyanobacterial lichens, and a critical revision of the lichens reported from southern California in the classic treatise by Hasse published in 1913. There is also a cumulative index covering all three volumes, a compilation of the new scientific names introduced (which include 186 new species), and an index to where the major keys are found.

Of course there are the odd spelling slips, such as “*Sktyella*” for “*Skytella*” (p. 297), and other minutiae a persnickety reviewer might point out, but these hardly distract from what is essentially a meticulously and superbly edited work. That Tom Nash has been able to exert such editorial dragooning to achieve accounts of such a consistently high standard cannot but be admired. And to realize his vision with a product that bears such a modest price! It sets a new standard for regional works on lichens, covering as it does the full range of lichens and lichenicolous fungi in this vast region. Further, as so many of species treated occur elsewhere, not only in North America but the Northern Hemisphere, this trio of volumes is surely something all lichenologists will both

want, and can afford, to have on their personal shelves (the three volume set is currently available for just US \$ 110).

Opredelitel' lichaininkov rossii. Vol. 10. Edited by Nina S. Golubkova. 2008. Nauka, St Petersburg, Russia. Pp. 516, figs 82. ISBN 978-5-02-026286-7. Price not indicated.

This is the tenth and final volume of the HANDBOOK OF THE LICHENS OF THE USSR/RUSSIA, which commenced publication in 1971 and is in Russian. The ninth volume appeared in 2004 (see MYCOTAXON 94: 386-387, 2005) and covered *Fuscideaceae* and *Teloschistaceae*. In contrast, the new volume deals primarily with genera outstanding from previous parts, and disposed through 21 different families. In all, 54 genera and 467 species are covered here. Unlike the earlier volumes, the individual generic accounts are identified as contributed by 12 authors on the contents page at the end. The largest number of genera treated in one family (18) is *Physciaceae*, followed by *Gomphillaceae* (5) and *Psoraceae* (5), and the largest genera covered are *Ramalina* (with 48 species) and *Rinodina* (with 78). The format follows earlier volumes, with keys, full descriptions, information on ecology and distribution, and half-tone photographs of selected species. Some of the pictures are of a better quality than seen in earlier volumes, and those of *Ramalina* will be especially appreciated as some are of rarely illustrated species. Treatments of the basidiolichen genera *Multiclavula* (2 species) and *Lichenomphalia* (4 species) are also to be found here. The literature covered is more up-to-date than in some earlier volumes, with citations into 2006.

In addition to the index to scientific names in the current volume, there is a most welcome index to the volumes and pages on which genera are treated in all ten volumes (pp. 509-512) – I have inserted a coloured Post-it* in my copy to facilitate its rapid location in future.

The completion of this work is a great tribute to the dedication of lichenologists in the former USSR and Russia, as much of it has been produced under the most difficult of circumstances. Sadly, many of those involved in the earliest volumes, and two with the present one, did not live to see its completion; and Nina Golubkova herself, who has done so much for Russian lichenology, also died this year.

Nordic lichen flora. Vol. 3. Cyanolichens. Edited by Teuvo Ahti, Per Magnus Jørgensen, Høður Kristinsson, Roland Moberg, Ulrik Søchting & Göran Thor. 2007. Nordic Lichen Society, Museum of Evolution, Uppsala University. Pp. 219, figs 1, maps 217, col. figs 232, photo CD. ISBN 978-91-85221-14-1. Price not indicated.

It has been a long gap since the second volume of this important work appeared in 2002, which focused on *Physciaceae* (see MYCOTAXON 87: 497-498, 2003),

but as pointed out by Per Magnus in the Preface, covering the lichens with cyanobacterial partners proved more difficult than at first perceived as many small genera had not been critically assessed in the region. Twelve families are covered, *Arctomiaceae* (2 genera), *Coccocarpiaceae* (1), *Collemataceae* (4), *Heppiaceae* (2), *Lichinaceae* (21), *Lobariaceae* (3), *Massalongiaceae* (3), *Nephromataceae* (1), *Pannariaceae* (9), *Peltigeraceae* (2), *Peltulaceae* (1), and *Placynthiaceae* (3). All accounts are authored by Per Magnus, apart from *Nephromataceae* and *Peltigeraceae*, which were prepared by Orvo Vitikainen. In cases where a genus also includes species that have only a green photosynthetic partner, these are also treated.

As only would be expected from these authors, the accounts are meticulously prepared, and largely follow the format of the earlier volumes. Maps for 217 species are included, along with 232 superb habit or detailed photographs in colour; an index to the collection details of the specimens photographed is provided. The CD contains the same photographs with separate files in two series, generic (with a file for each genus) and specific (a single alphabetical list). Of especial value amongst these are those of the undersides of *Peltigera* species, where the nature of the veins and rhizines are not always easy to grasp from the written word or sketches; I am sure those pages will soon become well thumbed!

Noting that there was a six-page appendix entitled “Nomenclatural novelties”, I went to that with some trepidation at the name changes that might be introduced. But what a relief when I found there were just three new combinations, *Epiphloea byssina* (syn. *Collema byssinum*), *Pterygiopsis concordatula* (syn. *Pyrenopsis concordatula*), and *Thallinocarpon nigrillum* (syn. *Thyrea nigrilla*), and 39 lecto-, neo- or epitypifications. Many of the epitypifications relate to names of common species based on illustrations in the 1742 *HISTORIA MUSCORUM* of Dillenius, and are welcome in now tying these names to specimens rather than figures. There is an index to synonyms, but surprisingly not to accepted species where I would have found one to epithets most helpful in view of the changing dispositions of some of the smaller species covered. Some other changes are found in the text, including the resurrection of the long-unused Massalongian generic name *Collolechia* dating from 1854 for the species previously referred to as *Placynthium caesium*; it differs from *Placynthium* in both thallus anatomy (crustose not squamulose) and apothecial characters (asci with an amyloid ring not a cap or sheath). I was also pleased to see the placement of *Thyrea nigrilla* resolved (see above) as it has also featured in *Gonohymenia* and *Lichinella* in recent times.

While focused on the Nordic countries, as so many of the species are known elsewhere in Europe or are circumboreal, this is a work lichenologists in general should endeavour to acquire. It is to be hoped that further volumes in the series

will follow at a more timely pace and aspire to the high standards for the series now set by the third.

Flora of Australia. Vol. 57: Lichens 5. Edited by Patrick M. McCarthy. 2009. CSIRO Publishing, P. O. Box 1139, 150 Oxford Street, Collingwood, VIC 3066, Australia <publishing.sales@csiro.au>. Pp. xx + 687, figs 183, col. plates 32, maps 654. ISBN 978-0-643-09664-6 (hard cover), 978-0-643-09665-3 (soft cover). Price AU\$ 180 (hard cover), AUS\$ 140 (soft cover).

The lichen volumes in this “flora” started publication in 1992, when five were originally envisaged (vols 54-58) with particular ones covering specified orders and families. The first to be issued (54, 1992) had a substantial introduction and dealt with nine families of *Lecanorales*, the second (55, 1994) *Parmeliaceae*, the third (58A, 2001; see MYCOTAXON 83: 505-506, 2002) genera from ten families taken from seven orders, and the fourth (56A, 2004; see MYCOTAXON 91: 514-515, 2005) nine families from three different orders. A changed policy has been adopted for the fifth volume, which is about twice the thickness of any of the previous four. Now, it is envisaged that the work will comprise ten volumes published at intervals of 1-2 years “as sufficient treatments of complete families become available” (p. xi). This is surely a more pragmatic approach to the eventual realization of the vision of this massive work, especially as with so few Australian lichenologists in posts it is partially dependent on contributions from specialists in other countries.

The new volume has partial or complete accounts of 21 families, and according to the Introduction (p. xi) covers 78 genera and 654 species and infraspecific taxa, bringing the total so far covered in the five volumes to a most commendable 1822. The major part of the present volume (338 pp.) is devoted to *Ostropales*: *Graphidaceae* (AW Archer) and *Thelotre mataceae* (A Mangold, JA Elix & HT Lumbsch) – families that are kept distinct for practical reasons here despite their synonymy having been proposed. To see *Graphidaceae* included was at first something as a surprise in view of the 2006 revision by Archer (see MYCOTAXON 107: 521522, 2007), but on closer inspection this proved not to be just a re-formatting, but to have not only many additional species but even further genera recognized; this reflects the rapid advances made in the understanding of the family even in the last three years. Other of the larger contributions deal with some of the smaller genera of *Arthoniaceae* (JA Elix), *Nephromataceae* and *Peltigeraceae* (SHJJ Louwhoff), *Pyrenulales* and *Trypetheliales* (A Aptroot), selected genera of *Teloschistales* (including *Buellia* and *Dirnaria*; JA Elix), and *Umbilicariaceae* (SHJJ Louwhoff). Various new scientific names are proposed, including *Schizotrema* gen. nov. (*Thelotre mataceae*), 27 new species (mainly in *Thelotre mataceae*), and 36 new combinations made (sadly none with MycoBank accession numbers).

The overall format is essentially that of earlier volumes, but particularly welcome here are the numerous halftones in the text; many are just macroscopic, but those showing ascospores in the accounts of the thelotremes will prove especially useful. However, I do hope that more colour plates can be included in future volumes, as these are especially valuable to newcomers to lichen identification. The whole has been meticulously edited, though I did find the frequent and incorrect practice of citing the authors after species epithets in the names of infraspecific taxa other than the type taxon a minor irritation. The volume merits a wide distribution not only amongst lichenologists concerned with Australian material, but all dealing with tropical and Southern Hemisphere lichens.

Biologia de líquens. Edited by Lauro Xavier Filho, Maria Estrella Lopez, Carlos Vicente Cordoba, & Eugênia Cristina Pereira. 2006. Âmbito Cultural Edições, Rua da Alfândega 115 Sala 704, Centro, Rio de Janeiro- RJ, Brazil. Pp. 619, figs, some col. ISBN 85-86742-14-7. Price 100 R\$.

This is essentially a multi-authored textbook in Portuguese, with contributions from 25 lichenologists mostly based in Brazil or Spain. In many respects it is an update of Xavier Filho's (1976) text, which has been the only general work on lichens available in Portuguese since that time. It is mentioned here as while mainly devoted to lichen structure, chemistry, ecology, and physiology, it also includes a synopsis of the orders of lichens known in Brazil, and further keys to the genera of foliicolous lichens – the latter prepared by Robert Lücking and Marcela Cárceres.

Xavier Filho L (1976) *MANUAL DE LIQUENOLOGIA BRASILEIRO*. Universidad Federal de Pernambuco, Recife.

Facetten der Flechtenforschung Festschrift zu ehren von Volkmar Wirth. Edited by Roman Türk, Volker John & Markus Hauck. 2008. Verlag Alexander Just, P. O. Box 53, Dorfbeuren, A-5010 Salzburg, Austria <verlag.just@utanet.at>. Pp. 616 + viii col. pl. [SAUTERIA no. 15.] ISBN 978-3-901917-08-0. Price 49 €.

Volkmar Wirth is one of the most respected lichenologists in Europe, so it is not surprising that this volume dedicated to him on the occasion of his 65th birthday attracted 33 contributions from specialists across the continent. These range from descriptions of new species to records from different regions from the Galapagos and Iran to Belgium, and include notes on some lichenicolous fungi. Of special note is the paper recognizing an additional species of *Parmelina* in Europe (*P. atricha*), that providing a revised circumscription of *Xanthodactylon*, and one with the realization that *Cheiromycina ananas* is a synonym of *Dictyocatenuolata alba*. Also very welcome is the late Anton Vězda's index to his *LICHENES SELECTI EXSICCATAE*, 1960-1991) which comprises

2500 taxa of lichens and lichenicolous fungi. The volume concludes with a list of Wirth's 160 publications in the period 1963-2008, and a list of the new scientific names for both taxa and lichen communities he has introduced. While I am sure that Volkmar will have appreciated the volume, I continue to question the value of such Festschriften as opposed to dedicated issues of regular lichenological journals as sadly the papers will not be readily accessible to most lichenologists.

Checklist of lichens and allied fungi of the Polish Karkonosze Mts. By Maria Kossowska. 2006. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland <ed-office@ib-pan.krakow.pl>. Pp. 131, figs 1. ISBN 978-83-89648-50-1. Price not indicated.

The Karkonosze Mountains are the highest in the Sudety Mountain range, reaching an altitude of 1603 m, and form a boundary between the Czech Republic and the former Silesia (now in Poland). The area has been studied by many well-known lichenologists from Flotow to Suza over the last 250 years, and this work aims to bring together information on the Polish side of the mountains. In total, 574 lichens and 22 allied fungi (i.e. lichenicolous or saprophytic species) are confirmed, while in the case of a further 17 it is unclear as to which side of the divide they were collected. Information as to the current status of species in the Mountains is not indicated and must await fresh field surveys, which this book could well help to stimulate. The arrangement is strictly alphabetical, with details of occurrences by region and with literature references. There is also an index to synonyms, and a German/Polish (Czech) gazetteer as wrestling with changing place names in the region is evidently a nightmare!

Biotic soil crust lichens of the Columbia Basin. By Bruce McCune & Roger Rosentreter. 2007. Northwest Lichenologists, 1840 NE Seavy Avenue, Corvallis, OR 97330, USA (www.nwlichens.org). Pp. iv + 195, col. figs. [MONOGRAPHS IN NORTH AMERICAN LICHENOLOGY no. 1.] ISBN 978-0-9790737-0-0. Price US \$ 30.

This is a super hands-on identification guide to an ecologically most important habitat: "Break your skin and blood emerges; break the skin of the earth and mineral soil emerges" (p.1). Following five pages of introduction, including information on collecting and curating (always a problem with lichens on friable soils!), 21 keys are presented arranged into six pragmatic sections: blackish; crustose yellow or orange; nonlobate crusts; fruticose or 3-D; lobate or foliose; and squamulose. Where species are keyed out, rather full descriptive information is provided, but what really makes this volume so special is the coloured photographs and photomicrographs. As the authors point out, "almost none of the lichen species growing in biotoc crusts in the Pacific Northwest

have been illustrated with colour photos in sufficient magnification and detail for confident identification" (p. 1). Not only are the habits shown in the photographs, but there are sections of ascomata, pictures of asci and ascospores, and even ones showing differential responses to UV-light. There are also asides on topics such as vagrant and erratic lichens, and a well-illustrated glossary. Unexpected in what is designed to be primarily a field guide is a new taxonomy for *Rhizoplaca* in the region, including the formal diagnosis of one new species and three new subspecies. A "must" for ecologists and lichenologists alike, and a great start to what promises to be a most important and much needed series of monographs on North American lichens. All concerned in the realization of such a super volume at such a reasonable price are to be congratulated.

***Cladoniaceae*.** By Ana Rosa Burgaz & Teuvo Ahti. 2009. Sociedad Española de Lichenología, Madrid, Spain. Pp. 111, figs 21, maps 82. [FLORA LIQUENOLÓGICA IBÉRICA vol. 4.] ISSN 1696-0513. Price not indicated.

The previous volume in this series, published in 2007, dealt with the crustose genera *Bacidia* and *Bacidina* (see MYCOTAXON 102: 449-450, 2007). This new number is especially welcome as dealing with a whole family, *Cladoniaceae*, which has two genera in the Iberian Peninsula; *Cladonia* with 81 species and subspecies, and *Pycnothelia* with just one. *Cladonia* is particularly species rich worldwide, with around 450 currently accepted species, and they can be notoriously difficult to identify. "Ted" Ahti has devoted much of his life to resolving species concepts and nomenclature in the genus in all continents, and Ana Rosa is one of Spain's most experienced lichenologists who has taken an especial interest in the genus in the Iberian Peninsula for many years. This combination of skills has had a synergistic effect in enabling this regional monograph to be realized. The text is entirely in Spanish, and after some general background on the family and its study plunges quickly to the keys. These lead to the characterization of four "supergroups": *Cladonia* (most species, with a squamulose primary thallus and brownish apothecia), *Cocciferae* (*Cladonia coccifera* and other species with red apothecia), *Crustaceae* (with a crustose primary thallus, and including the formerly recognized *Cladina* and the *Cladonia uncialis* group), and *Perviae* (*Cladonia crispata* and other species with perforated podetia). A combined key covering all species treated follows, with generally clear-cut dichotomies that could easily be followed, with the aid of a pocket dictionary, by those not conversant with Spanish. I was relieved to see that the species entries themselves were arranged alphabetically by epithet and not by supergroup, as this makes looking up species so easy. Each account has the essential nomenclatural information on place of original publication of the name, and basionym where appropriate, along with details of the type and references to selected published illustrations. The descriptions are more

detailed and meticulously prepared than is often seen for ones of macrolichens, and include anatomical details of the thalli and podetia as well as chemistry. The ecological notes reflect the extensive experience of the authors in the field, and distribution down to community (province) and state level is summarized and also shown in dot-maps collected together to the back of the volume. Many of the species have wide distributions, and some have only recently been recognized in Europe, such as *C. hammeri* described from California in 2002. But there are also endemics or near endemics, including *C. iberica* which I frequently see in the mountains just to the north of Madrid. There are no photographs, but most species are illustrated in clear life-like line drawings by J. L. Castillo; 3-4 are presented together in each plate. Notes on four species that might be expected in the region and to be searched for are also included. This is a *must* for the shelf near the bench of all lichenologists working with macrolichens.

The montane heathland lichen guide. By Andrea Britton. 2008. The Macaulay Institute, Craigiebuckler, Aberdeen AB15 8QH, UK <j.lund@macaulay.ac.uk>. Pp. 50, col. figs. ISBN not indicated. Price £ 10.99.

A spiral-bound, coloured, and reputedly waterproof guide at a size that will easily slip into the side pocket of a backpack. The focus is species in the prostrate montane shrubs of Scotland's highest mountains. It has pragmatic information on identification, chemical testing, preservation, and collection – with a strong warning on unnecessary collection. This is wise as I suspect there is already more of one species that is mentioned (but not illustrated), *Alectoria ochroleuca*, in herbarium cabinets than growing today in Scotland. Twenty-seven species are featured, mostly at one per page, with fine habit photographs and notes on the characters, chemical tests, habitat, and similar species, as well as a 10 km square distribution map. *Cladonia* species predominate, especially bushy species (i.e. subgen. *Cladina*) to which there is a “simple key”. The photographs are at a sufficiently high magnification to show the apical branching patterns, and most must have been taken from fairly fresh material as the colours all seem true to nature. I would, however, have preferred that of *Solorina crocea* to be at a higher magnification so the veins on the bright orange underside were visible. There is also a “complete list” of terricolous species found in this habitat in the UK, which includes crustose species as well as macrolichens. The author is a plant ecologist, so it is perhaps not surprising to find a table showing the occurrences of species in 11 National Vegetation Classification (NVC) categories, of which three have a major lichen component: *Calluna vulgaris*-*Cladonia arbuscula* heath, *Vaccinium myrtillus*-*Cladonia arbuscula* heath, and *Juncus trifidus*-*Racomitrium lanuginosum* heath. The booklet concludes with a glossary and recommended further reading and websites. It will be a boon

to ecologists undertaking survey work in montane heathlands, and neophyte lichenologists struggling to identify *Cladonia* species.

Lichen Flora of Central India. By S. Muthukumar & J. L. Tarar. 2006. Dattsons, J. Henru Marg, Sadar, Nagpur 440001, India. Pp. x + 360, plates 28, tables 3. ISBN 81-7192-062-4. Price US \$ 54, Rs 975.

While it is pleasing to see more books being produced on Indian lichens, this one has some unexpected features that set it apart from most regional treatments, and also problems as a work of the 21st century. These include a detailed and extensively referenced account of the history of lichenological exploration in India, a review of phytogeography and distribution in India (including principal phytosociological syntaxa), overviews of thallus and reproductive structures, and a survey of economic uses. The major part of the book, however, comprises ten chapters each devoted to particular groups or genera of lichens: arthonioid, graphidean, thelotremoid, lecideoid, opegraphoid, *Parmelia*, *Pertusaria*, *Pleurothecium*, pyrenocarpous lichens, and *Usnea*. However, these are not straightforward systematic accounts with keys for identification, but rather discursive essays with eclectic systematic material – and do not all have parallel contents.

For example, the chapter on graphids starts with an introduction to the family, first in India and then historically from 1724, followed by considerations of the criteria for generic and species delimitations. In this, the now outdated artificial four-genus system used by Zahlbruckner in the 1920s is used with no mention of Staiger's (2002) seminal work and the generic concepts she adopted. The morphology of the discs, the nature of the "labia", and convergence/divergence in these features are then discussed, leading to a consideration of exciple structure, ascospores (with five size categories), and chemistry; these characters used to place the species in 14 categories in a Table (pp. 86-87). An "Appendix" aiming to list all taxa of the family previously recorded from India follows, with references, and in which those known from central India are asterisked (six of 113 species). The four genera are then treated in turn, with a key, descriptions, and information on the ecology and distribution of each species. Taking *Graphina* as an example, 41 species are listed as previously known from India with just three asterisked as present in central India, while the subsequent key and species descriptions cover 11 of which eight are not in the list of 41; these I presume are those now known in central India and include taxa discovered by the authors.

The longest chapter, of 50 pages, is titled "a treatise to pyrenocarpous lichens." This lacks a key to the genera, which are just listed under five spore

categories, but has keys to species within the accepted genera. Amongst these I was amazed to see *Microthelia* still being used, and for a variety placed as a synonym of *Mycomicrothelia conothelena* many years ago (Hawksworth 1985). But there are even stranger and potentially misleading points, such as the treatment of *Buellia* and *Dermatocarpon* in the arthonioid lichen chapter. Macrolichens receive but cursory treatment, and apart from *Dermatocarpon* only *Parmelia* s. lat. (four species) and *Usnea* (one) make the book. In the case of *Parmelia*, most generic segregates proposed by Hale are not mentioned, let alone the changes in generic concepts that have arisen from the intensive molecular phylogenetic studies that started publication around the turn of the century. Such misunderstandings and lack of expected comments may be partly understandable in the context of the 26-page Reference section; the only papers cited that appeared after 1990 are by Indian authors, and the latest of those are ones by the two authors of this book and are only from 2000. No information from molecular phylogenetic studies or recent classifications has consequently been considered.

In addition to a short glossary, each page idiosyncratically ends with a rule below which is a statement of some lichenological “fact”; examples include “Lichen in shade accumulate more chlorophyll content,” “The growth of lichen is normal sigmoid pattern,” and “Crustose species germinates in 1 or 2 hours” – many of the comments would not withstand critical scrutiny . . .

So how can this work be summarized? It is not an overall account of the lichens of the region, indeed there is only a key to the genera treated. But it apparently did have a mission, which is expressed in the Preface: it was “moulded to exemplify lichen taxonomy by adhering to spore based concepts for delimitation of taxa” (p. vi); i.e. a long-lost cause. It is unfortunate that the authors appear not to have had access to much modern literature or guidance. There are no acknowledgements, even to assistance received from other Indian lichenologists, and sadly they appear to have worked diligently but very much in isolation. However, Dr Muthukumar only received his PhD in 2000, from a university in Nagpur, and the back flyleaf indicates that he is now researching the lichens of the Marathwada region; hopefully he is now also making contact with other lichenologists who can induct him into current systematic concepts and the modern literature.

Hawksworth DL (1985) A redistribution of the species referred to the ascomycete genus *Microthelia*. BULLETIN OF THE BRITISH MUSEUM (NATURAL HISTORY), BOTANY 14: 45-181.

Staiger B (2002) Die Flechtenfamilie *Graphidaceae*: Studien in Richtung einer natürlicheren Gliederung. BIBLIOTHECA LICHENOLOGICA 85: 1-526.

Macrolichens of Sikkim. By G.P. Sinha & K.P. Singh. 2005. Botanical Survey of India, 5th & 6th Floor, F-Wing, C. G. O. Complex, Salt Lake City, Kolkata 700 064, India <bsi_headquarters@rediffmail.com>. Pp. iii + 273, col. figs 95 [?], maps 1, tables 1. ISBN 81-8177-011-0. Price Rs 1080, US \$ 115.

This is a very different work to Muthukumar & Tarar's account of the lichens of central India considered above, and is prepared by two of India's current generation of active lichenologists. It is the result of six years of intensive collecting on 12 expeditions in the years 1994-2000 which ranged up to an amazing 5500 m in altitude. The 1775 collections made were "authenticated" using the collections in the National Botanical Research Institute in Lucknow, which have been built up mainly by India's most renowned lichenologist, Dharani Awasthi, and assistance was also secured from other lichenologists with particular specialisms both within India and internationally. It starts with a succinct and pertinent 14-page introduction providing background to the region, detailing the history of its lichenological exploration, and presenting key aspects of the strikingly different habitats and lichens found in them from the tropical to the alpine (also shown in colour). Twelve lichens that have uses to local people in the state are also enumerated; these have vernacular names and are used for purposes from treating eczema and urinary troubles to consumption as vegetables. Prior to this study, 248 species were known from the state. That total has now been increased to 320 species, of which six are first records for India. Seven species are only so far known from the state, and others confined to the Eastern Himalayan region and Tibet occur. There is a key to the 72 genera represented, and then accounts of the families and genera; frustratingly these are arranged by family rather than alphabetically, according to a classification that is not explained and which separates families now known to be the same (e.g. *Caliciaceae* starting on p. 24 and *Physciaceae* on p. 171); the index consequently needs frequent consultation, especially as the page numbers for the generic accounts are not cited in the generic key. Each genus has a description and comment on the species numbers worldwide and in the region, a key where more than one is represented, and species accounts have the full bibliographical reference to their place of publication and selected usages, a description, notes on ecology and distribution, and a list of specimens examined. In addition, just under a third of the species are illustrated by colour photographs, not all as sharply focused as one might expect today, and mostly evidently taken from preserved specimens to judge from the background material and especially the colours – users need to be aware that the colours are not always the same as they would be in fresh specimens. However, I was particularly surprised by the picture of *Sulcaria virens* which appears reddish orange rather than bright emerald green as in my experience the true colour is maintained well even in ancient collections! In contrast to that example, the

yellow shown in *Alectoria ochroleuca* is true to nature. The species illustrated include a number which have surely not previously been featured in colour, such as *Heterodermia himalayensis* and *Umbilicaria yunnana*. Generic concepts are in general up-to-date, though in the case of the parmelioid lichens the changes arising from the last round of molecular phylogenetic studies are not allowed for as they would have appeared too late. In summary, a solid contribution to the lichens of this fascinating region, and one which will be of particular value to all endeavouring to identify macrolichens from the highest altitudes in the Himalayan and adjacent regions.

[**Lichen identifier**]. By Wanaeuk Saipankaew et al. 2007. British Council, Chiang Mai, Thailand <www.britishcouncil.or.th>. Pp. vi + 82, illustrated. ISBN 974-94705-8-3. Price not indicated.

This little spiral-bound book, in Thai apart from the Foreword and last six pages, provides an introduction to the nature and identification of lichens, along with coloured photographs of species illustrating a selection of common genera in the country, and an introduction to recording as a part of air quality surveys – an issue of ongoing concern in and around urban centres in Thailand. It is mentioned here as having so much material in Thai it will be useful in introductory courses on lichens in the country.

MISCELLANEOUS

Species: A history of the idea. By John S. Wilkins. 2009. University of California Press, Berkeley, CA, USA . Pp. xiv + 306, figs 11 [SPECIES AND SYSTEMATICS Vol. 1.] ISBN 978-0-520-26085-6. Price £ 34.95.

It is instructive for mycologists involved in the description and circumscription of new species to be aware of the practices in other areas of biology. This is far from the first book to examine species concepts, but complements others of recent years on my shelves, such as those of Claridge et al. (1997), Wilson (1999), and Wheeler & Meier (2000). Not only is it single-authored, and by a philosopher of science rather than a practicing taxonomist, it goes to the roots of the origin of the concept. The evolution of the idea is traced in depth from the emerging concept of Aristotle in classical times, through the medieval to the birth of modern science, the nineteenth century debates and the impact of Darwin, to the “new systematics” synthesis of the early twentieth century and modern debates. The modern debates receive only 19 pages, and at first this seems too little, but perhaps they are to be expanded in future volumes in this new book series? However, this section does address reproductive isolation, evolutionary, phylogenetic and other less familiar concepts such as the ecological, the “aberrant” (including agamo-, nothospecies), and the

palaeontological. Wilkins concludes that “SPECIES has always been thought to mean the generation of similar form,” and perhaps more surprisingly that “there has been no morphological species tradition as such, apart from the use of morphology to IDENTIFY species” (p. 232; his emphasis). No neatly packaged definition emerges, instead he suggests that we “might stop trying to overgeneralize species concept(ion)s or speciation mechanisms to all species” which would “reduce the heat in a number of biological forums” (p. 234). These are sentiments with which I definitely concur, and seem in line with my personal pragmatic species concept I both employ and commend: “species are groups of individuals separated by inheritable character discontinuities and which it is useful to give a species name to” (Hawksworth 1996: 32).

Claridge MF, Dawah HA & Wilson MR (eds) (1997) *SPECIES: THE UNITS OF BIODIVERSITY*. Chapman & Hall, London.

Hawksworth DL (1996) Microbial collections as a tool in biodiversity and biosystematic Research. In: *CULTURE COLLECTIONS TO IMPROVE THE QUALITY OF LIFE* (RA Samson, JA Stalpers, D van der Mei & AH Stouthamer, eds): 26-35. Centraalbureau voor Schimmelcultures, Baarn.

Wheeler QD & Meier R (eds) (2000) *SPECIES CONCEPTS AND PHYLOGENETIC THEORY: A DEBATE*. Columbia University Press, New York.

Wilson RA (ed.) (1999) *SPECIES: NEW INTRODUCTORY ESSAYS*. MIT Press, Cambridge, MA.

Taxonomic Literature. Supplement VIII: Fres–G. By Laurence J. Dorr & Dan H. Nicolson. 2009. A. R. G. Ganter Verlag, FL-9491 Ruggell [Distributed by Koeltz Scientific Books, P. O. Box 1360, D-61453 Königstein, Germany <koeltz@t-online.de>]. Pp. viii + 550. [REGNUM VEGETABILE Vol. 150.] ISBN 978-3-906166-75-9. Price 94 €, US\$ 141.

This publication completes the “supplement” to the first volume of what has become affectionately known as “TL-2” – the second edition of the standard reference work *TAXONOMIC LITERATURE* prepared by the late Frans A. Stafleu and the late Richard S. Cowan. The eight supplements, the first of which appeared in 1992, expand the coverage in the first volume which treated works by authors A through G in a more eclectic manner than that accorded to authors in the six other volumes of the main work. This final supplement, bring the total number of volumes constituting TL-2 to 14, will be especially appreciated by mycologists as it treats six more of works by Elias M. Fries, which can be added to the 34 of his publications covered in the 1976 volume. There is also a synopsis of three generations of the Fries family, several members of which made important scientific contributions in various aspects of botany and mycology. The complete set is a must for all libraries dealing with botanical and mycological (including lichenological) taxonomy and nomenclature, and also those involved in editing taxonomic works.

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- Boletus roodyi* B. Ortiz, D.P. Lewis & Both, p. 212
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- Chasakopama* Manohar., Bagyan., N.K. Rao & Kunwar, p. 459
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- Cyberlindnera euphorbiiphila* (Van der Walt) Minter, p. 474
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- Cyberlindnera japonica* (Kurtzman) Minter, p. 474
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- p.419, add: Kucera, Viktor & Pavel Lizon. *Ascocoryne striata* comb. nov.
93: 163-165. 2005.
- p.419, add: Lizon, Pavel, see Kucera & Lizon

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| p.505, line 28 | for: <i>Dictyochaeta caatingensis</i> | read: <i>Dictyochaeta caatingae</i> |
| p. 46, line 1: | for <i>astroniiphila</i> | read <i>astroniiphila</i> |
| p, 209, Intro., line 9: | for <i>D. varians</i> var. <i>pteridophyllum</i> | read <i>D. varians</i> var. <i>pteridophyllum</i> |
| p, 209, line 8: | for <i>D. varians</i> var. <i>variens</i> | read <i>Dasyscyphus varians</i> var. <i>variens</i> |
| p, 210, line 15: | for (1889) | read (1889) [as " <i>Dasyscypha</i> "] |
| p, 212, line 8: | for (1889) | read (1889) [as " <i>Dasyscypha</i> "] |
| p, 212, line 37: | for (1921) | read (1921) [as " <i>Dasyscypha</i> "] |
| p, 215, line 13: | for <i>Dasyscypha varians</i> Rehm, Hedwigia 39: 94 (1900) | |
| | read <i>Dasyscyphus varians</i> Rehm, Hedwigia 39: 94 (1900) [as " <i>Dasyscypha</i> "] | |

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| p.139, bottom entry – p. 140, top 4 entries | Font should be plain, not bold. |
| p. 507, lines 21–22 (<i>G. custos</i>) | |
| for: MUCL 47213 | read: MUCL 51732 |

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Step 3—FINAL SUBMISSION: After authors receive their manuscript accession number and make revisions requested during nomenclatural review, they should send (i) a completed MYCOTAXON submission form; (ii) separate text files for main text, tables, and legends; and (iii) art files to the *Editor-in-Chief* <editor@mycotaxon.com>. **Only** text and image files considered ready for immediate publication should be sent at this time. The *Editor-in-Chief* will try to acknowledge receipt of files within two weeks. Authors are asked to wait at least 14 days before sending a follow-up query, to avoid unnecessary Email traffic near press deadlines or during temporary closures of the editorial office.

Step 4—PRESS PREPARATION: After preparing a press-quality PDF from the author's text and art files, the *Editor-in-Chief* sends journal entries for the nomenclatural novelties and author index pages with the PDF proof to all coauthors for approval. Editorial errors are always corrected free of charge, but authors who ask the *Editor-in-Chief* to correct errors present in their original files will be charged \$10 per correction (minimum charge of \$40). Payment arrangements of all fees should be made by writing the *Business Manager* <subscriptions@mycotaxon.com>.

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FROM THE *EDITOR-IN-CHIEF*

TO OUR READERS

SIC TRANSIT BOOK REVIEW EDITOR — Finishing a full decade of service to our journal, DAVID HAWKSWORTH departs MYCOTAXON after shepherding a formidable opus (pp. 509–562) comprising excellent critiques of 44 books running the gamut from the 50-page MONTANE HEALTHLAND LICHEN GUIDE to the 1046-page LICHENS OF GREAT BRITAIN AND IRELAND while mother-henning the DICTIONARY OF FUNGI–*Phytophthora*–FUNGA NORDICA–*Alternaria*—TL2 gamut in-between. We gratefully thank ‘Sir’ David (a pet name for our obliging colleague, even if that title is not in the official CBE nomenclatural pantheon), wish him well in his current passion of forensic mycology, and anticipate the future reviews that will flow from his prolific pen.

ELSE VELLINGA will join the MYCOTAXON masthead in 2010 as solitary Book Review Editor (not ‘co’-editor, as speculated in our last volume). With considerable editorial persuasion and after mulling the logistics of publishers sending volumes to two different editors, Dr. Vellinga agreed to assume the post with the blessings of her predecessor. Else brings formidable knowledge of taxonomy and nomenclature to her new position. Morphologically and nomenclaturally trained in the Netherlands, she has helped edit the FLORA AGARICINA NEERLANDICA series. Molecularly tempered in the UC-Berkeley Bruns’ lab, she now spearheads a careful revision of many difficult agaricaceous ‘mega’-genera. Finally, as author of MCILVAINEA’s well-received “Mycological Florilegium” for the past few years, Else has published an entertaining expert overview of recent important mycological journal papers. We welcome Else with considerable enthusiasm and invite those interested in obtaining or writing book reviews to contact her at (ecvellinga@comcast.net) or 861 Keeler Avenue, Berkeley CA 94708 U.S.A.

MYCOTAXON 110 — Our final 2009 volume of 580 pages contains 62 papers by 190 authors & co-authors representing 36 countries and assisted by 86 expert reviewers. There are 133 new fungal names proposed. With 2009 accessions standing at 244 on December 10 and with more new manuscripts arriving daily, 35 of the 70 remaining unpublished manuscripts are already approved for Mycotaxon 111.

As always, the drawings submitted by our authors demonstrate the renaissance stature of today’s scientists. Twelve mycological and editorial advisors were polled to select the cover for this issue, and the decision was — as usual — quite difficult. Three color plates vibrantly illustrate a new *Racocetra* species (pp. 203 & 207) from Benin (Africa) and a rare *Xeromphalina* (p. 249) that has vaulted from Spain across Europe to Macedonia and Turkey.

The journal’s new formal NOMENCLATURE SECTION begins with a formal report on the deliberations of the Nomenclature Committee for *Fungi* and concludes with a rousing opinion regarding the (un)workability of a new mycological Code. Enjoy!

Warm regards,

Lorelei L. Norvell
MYCOTAXON *Editor-in-Chief*
8 December 2009

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For exchange only, contact Eva Zaletova, Institute of Botany, Slovak Academy of Sciences, Dubravská cesta 14, 845 23 Bratislava, Slovakia, <eva.zaletova@savba.sk>. ISBN 0-930845-14-5 (hardbound ed.), 0-930845-15-3 (softbound ed.)

Fungi of China, by S. C. Teng

Mycotaxon, Ltd. 1996. Hardbound, xiv + 586 pp., 426 illustrations, map, portrait, index, 8-1/2x11 inches. \$79.00.

Airmail price varies by country: enquire. ISBN 0-930845-05-6.

EDITED BY RICHARD P. KORF, WITH A FOREWORD BY TENG'S DAUGHTER, ROSALINE Z. DENG.

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Useful references, detailed tropical distribution, and hosts or substrates are provided for each species.

CONTRIBUTING AUTHORS: Shuang-Lin Chen, Lin Guo, Shou-Yu Guo, Ying-Lan Guo, Shu-Xiao Sun, Shu-Xia Wei, Hua-An Wen, Xiao-Qing Zhang, Jian-Yun Zhuang & Wen-Ying Zhuang.

Higher Fungi of Tropical China, EDITED BY WEN-YING ZHUANG

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Some 5056 named species belonging to 1192 genera of higher fungi hitherto known from tropical China are listed.

Useful references, detailed tropical distribution, and hosts or substrates are provided for each species.

CONTRIBUTING AUTHORS: Lin Gou, Shou-Yu Guo, Ying-Lan Guo, Xiao-Lan Mao, Shu-Xiao Sun, Shu-Xia Wei, Hua-An Wen, Zhi-He Yu, Xiao-Qing Zhang, Jian-Yun Zhuang & Wen-Ying Zhuang.

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